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MUD AND CONTINENTS.

BY GRANT ALLEN.

THE world's debt to mud is a very great one. To that much despised and unpicturesque mess of mountain detritus, ground by glaciers or worn by rain, and rolled down by rivers into seas and valleys, we owe the greatest habitable plains and cultivable prairies of the earth's surface. I don't mean merely in the sense of sedimentary deposit, raised again to the dry land by internal energies as solid rock: that, though once in some cases mud, is now recognisable mud no longer; it comes to us so disguised by pressure and heat that its own parent rivers would hardly know it for their own offspring. No, I mean mud, pure and simple: mud that still visibly confesses its mudship; mud whose essential muddiness of nature nobody can possibly deny or cavil at. Of that highly useful but not very ornamental or poetical material the great basins of the Nile, the Euphrates, the Ganges, the Indus, the Mississippi, and the Amazons are almost all still undoubtedly composed, and to that they owe their unusual fertility.

In a certain abstract and general way, to be sure, we have all been familiar with this fundamental fact any time the last fifty years—provided our years yet number half a century. But as things come home to one far more vividly, and are realised more fully in all their bearings when one sees them, as Horace says, subjected to ocular demonstration, I will confess that I have never recognised the importance of mud quite so fully as during the late inundations in the North Italian lake district and the valley of the Po, where I have been spending what I will venture to call a hard-earned holiday during the last week or two, and observing on every side the immense effect of even a single autumn's rainfall and snow-flood.

Locarno, near the head of the Lago Maggiore, is an admirable place for beginning the study of the land-forming action of mud and rivers. Originally, one can plainly see from the contour of the mountains as they descend into the plain, the lake formed a small bay just south of the spot where the town now stands; and into this bay the torrent of the Maggia, which flows close by, emptied its waters, heavily laden in times of spate with tons upon tons of Alpine débris. At the present time, however, the mud of the torrent has not only filled up all this narrow bay, but has also sent out an immense fan-shaped mass of alluvial deposit far into the body of the lake itself. The alluvial plain thus formed covers a space about two miles long by three broad, and it is daily growing under one's very eyes. The late floods have added many yards to its outer edge, and the swampy margin next the lake gets gradually reclaimed by natural means as fresh material is deposited on its banks from time to time by the roaring torrent.

As yet, the fan-shaped mud-sheet deposited by the Maggia, though it pushes out for at least a mile into the centre of the lake, has not succeeded in entirely filling up the space in front, and so cutting off the upper portion of Maggiore from the main sheet of water below it. But in time, as the mud extends further and further out into the deep water, it will finally reach the opposite bank; and then the upper end of Maggiore will consist of a separate pond, divided from the main lake below by a low and fertile alluvial plain. This upper pond itself will in time be filled in by the ever increasing mud-banks of the Ticino, the river whose water forms the main feeder of all Maggiore, and which flows into the lake above Locarno: for the Ticino, too, has a delta of its own, which similarly extends lakeward with every freshet. At one time, indeed, the Lago Maggiore must have spread as far north as Bellinzona, some twelve miles above; but those twelve miles have now been filled in from shore to shore with the débris of the river, forming solid land in its older and upper portion, and marshes or swamp in the newer part as one approaches Locarno.

The western bay of the Lago Maggiore, on whose bank stand Pallanza, Stresa, and Baveno, enables one to test the correctness of these explanations by applying them to a still more advanced stage in a similar land-forming process. Into that western bay the river Toce, whose valley forms the southern approach to the Simplon Pass, empties its waters, laden with the detritus of the glaciers and torrents of the great Alpine range from Monte Rosa to the Monte Leone. Now, the Toce, like the Maggia, enters the western bay sideways; and the fan of mud which it has deposited at its mouth has therefore at last succeeded in cutting off the end of the bay entirely from the main lake. The smaller sheet of water thus isolated is known as the Lago di Mergozzo; and it is separated from the rest of Maggiore by a low and muddy plain, through which a sluggish river empties its waters with slow meandering into the main basin. But if, from the summit of the neighbouring Mont' Orfano, you look down upon the two lakes, the greater and the lesser, you can see at once by the continuity of the mountain outline that they were formerly both one; while the shallow sheet of alluvium that separates them sinks at once when seen from that height into its proper insignificance as a mere mud-bank.

The well-known view of the eastern end of the lake of Geneva from the platform at Glion still further impresses the mode of action of these torrent streams in filling up lakes with an alluvial mud-sheet. Observed from that point, it is quite clear to the most untrained eye that a long arm of the lake once extended right up the Rhone valley as far at least as Bex and St. Maurice, while other subsidiary lakes apparently occupied the flat bottom about Martigny and Sion. But the mass of mud brought down by the glaciers and streams on either side from the Alpine range and the Bernese Oberland has now succeeded in covering the whole of this vast arm with a flat and level mud-sheet, which on the low shore between Villeneuve and Bouveret is yearly spreading itself further into the lake with marvellous rapidity. There can be little doubt that in time the Rhone deposits will fill up the whole lake of Geneva, as the Ticino will fill up the bed of Maggiore, the Adda that of Como, the Oglio Iseo, and the Sarca Garda.

But when, from the narrow theatre of the lakes and mountains, one emerges upon the broader scene of the Lombard plain—that interminable plain of poplars and vines that stretches from Turin in one monotonous level down the valley of the endless Po to Venice and Ravenna—it comes upon one with a burst of personal realisation that this, too, is one gigantic mud-sheet; that rivers can fill up, not only lakes and minor bays or tarns, but vast gulfs and

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branches of the sea as well. It is quite clear that in the beginning of the recent geological period, the skeleton (so to speak) of Upper Italy consisted only of the Alps and Apennines, while a mighty bay, almost comparable in size to the Adriatic (which is in fact its lower still unsilted portion) spread up to the very base of the two mountain ranges. But into this bay the rivers and torrents of the twin mountain systems brought down their mud with ceaseless activity, gradually filling it up with alluvial detritus. Step by step the rivers won upon the bay, at first, no doubt, as distinct streams, each with its own minor delta: but at last they almost all united in the single central channel of the Po, which at present carries off the joint waters of the Ticino, the Adda, the Adige, and the Mincio. Even now, however, the Brenta and a few other Alpine streams have separate outlets; and their mud must fill up a good deal more of the Adriatic before they succeed in joining the Po some forty or fifty miles east of its existing debouchure. But in the long line of marshes, sand-banks, and islets which spread from Venice along the coast to Comacchio and Ravenna, we see this process of gradual silting up now actually in action and daily increasing.

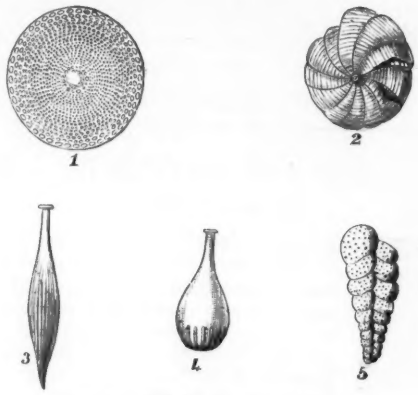
And what is thus taking place on a comparatively small scale before our very eyes in the Po valley, has taken place and continues to take place in a vastly greater way over the valleys of the Nile, the Ganges, and the Mississippi. India, for example, at the dawn of the modern period, consisted only of a vast island, the Deccan, bounded on the north by an arm of the sea, which spread from the Indian Ocean to the Bay of Bengal, and from the base of the Himalayas to the base of the Vindhyas. But the rivers which flowed from the mountains on either side have gradually filled up the whole of the intermediate sea with those vast alluvial deposits which we now know as the Ganges and Indus valleys; while the Ganges especially is still increasing its delta and carrying huge floods of Himalayan débris into the Bay of Bengal with astonishing and almost incredible rapidity. The eternal hills are for ever being ground down by rain or glacier, and the material thus produced is for ever being deposited by rivers in arms of the sea to form those immense alluvial plains which are the chief seat of human population.

PROTOPLASM A BUILDER.

By HENRY J. SLACK, F.G.S., F.R.M.S.

EVERYONE who looks through a microscope at such objects as the shells of foraminifera or the artificial manufactured-looking spiculæ of many sponges, is struck by their curiosity, or their elegance, but there the interest ends unless it is enlarged and supported by some elementary scientific knowledge. The architectural and implement-forming abilities of minute jelly specks, operating without tools, and without any structure analogous to the organs of higher creatures, is not only wonderful, but beyond the powers of science to explain, though we may acquire some notion of how the work is performed.

If we look at an *amœba* under a magnification of a few hundred times linear, we see a small bit of jelly chemically allied to white of egg, and in it are embedded numerous particles varying in translucence and in refractive power; but no enlargement, and no persistence in observation, enables us to assign particular functions to any of these particles, though we know they are employed in different kinds of work. We cannot impute conscious purpose to any of the lower forms of life, but when an *amœba* goes slobbering about in search of food its proceedings are far from mere random exertions of mechanical power. It is not obliged to make a mouth opening at any point unless, so to speak, it wants to close over an object that suits it. Some action of its surroundings upon it stimulates it to move about, and when its surface touches some small object it can assimilate it receives an impulse to take it in. Some of its molecules



GROUP 1 REPRESENTS FORAMINIFERA.

act like nerves, receiving impressions from without, and then determining other molecules to make the movements by which its living is obtained. We see some of the *amœbæ* protruding long delicate threads of protoplasm, while others only put forth thicker and blunt ones. These operate as feelers fumbling for prey, to which they are able to adhere and to engulf them, they can also anchor the part that is most advanced and drag the main body after it. This means that they have the power of regulating their stickiness, holding fast or letting loose as their mode of progression requires.

When they swallow an object we can see that they surround it with a clear space containing a fluid which acts chemically and digests it. Here, again, is a reception of and a response to, a stimulus from a foreign body. Somehow, the molecules able to be impressed in this way must arrange themselves in a particular alignment to transmit force in a definite direction. For the moment, the pattern they form does work like that of an organ in higher animals. At any part of their body there are molecules ready to fall into rank and perform special work.

In their simplest conditions *amœbæ* have no formation of any structure to busy themselves with, but some of them put forth a bundle of *villi* or slender bristles.

Passing from naked *amœbæ* to the house-building foraminifera, we find structures that look like the work of cleverly-used tools, or special organs, performed by bits of protoplasm that have nothing of the kind. First let us consider that the living jelly speck has to obtain the material for its building under what might seem great difficulties. It wants carbonate of lime, and the sea water it lives in contains only an infinitesimal quantity of that substance. In a thousand parts of the water of the Mediterranean there is 0·114 of one part of carbonate of lime, and less in the British Channel. By a chemical process it has to obtain this lime particle by particle, and it has to deposit each particle with exactness, as a good mason does with his bricks in erecting a house.

There are immense numbers of foraminifera differing from each other—so called species—each building according to its own pattern, and if extreme varieties or species are examined they might be supposed to belong to different

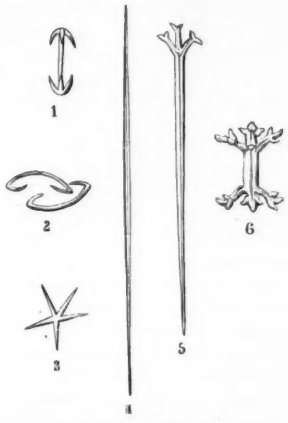
families, but when the known species are studied in a series all the forms are seen to be related to each other and allied by connecting links. Obtaining the carbonate of lime and building it up in so many curious patterns is done by small bits of protoplasm in which no one can detect any structure capable of indicating what pattern they are able to form, or how they can transmit the ability to their descendants through countless generations. If we look at the shells of the polycistina we see singularly beautiful specimens of what looks like ornamental glasswork, the material being

GROUP 2.—POLYCISTINA.

silex, with which we are familiar in the form of flint. But sea-water contains so little silica that it is usually left unmentioned in the published analyses.

Chemical processes were formerly supposed to be controlled in living bodies by an imaginary vital force, but this delusion has been dispelled, and it is found that they act in organisms as they do in laboratories, the part of the organism being to provide suitable apparatus to bring the right things together and facilitate their work. Each acting membrane of a gland, for example, being adapted to give a preferential entrance or exit to particular fluids holding certain matters in solution, just as a bit of parchment paper lets solutions of crystalline bodies pass through it, while the gummy or colloid sort of matter is retained.

The protoplasm of sponges varies in constructive powers according to the species. Some kinds, like toilet sponges, form a horny skeleton, others make one of carbonate of lime, and others of silex. In these great variety of pattern may be



GROUP 3.—SPONGE SPICULES.

discovered, many of great beauty, Many sponges make themselves very unpleasant for their enemies to eat by filling their soft parts with implements like pikes, darts, barbed spears, exquisitely made fish hooks, caltrops, &c. &c.

Different species use different weapons, just as different races of pugnacious men do. The effect is, that if an enemy takes a bite, the result is as uncomfortable as eating a pudding full of pins.

The protoplasm is chemically the same kind of substance wherever it is found, and no microscopic examination of it informs us what kind of constructive work it can perform. There must, however, for each special kind of work be a transmission of motion or force in special directions. The arrangement of mineral substances in the patterns required is not effected by simple precipitation of the lime or silex from its solution. The living substance grows into the shape required, and the mineral stuff is infiltrated into it.

The hyaline glassy foraminifera build their shells with numerous minute holes to let fine threads of protoplasm pass through and select their food, beside performing respiratory functions. In polycistina are similar apertures, usually larger than in most of the foraminifera.

The figures copied from the "Micrographic Dictionary" will illustrate the preceding remarks.

ON THE UNIVERSAL ACTION OF GRAVITY.

BY THE LATE R. A. PROCTOR.

FEW even among men of science appreciate the amazing mystery of that force which we call gravity. The way in which the property of universal attraction as now recognised is generally dealt with resembles that in which of old the property of terrestrial attraction was thought of by those who observed its effects. Men knew that objects left unsupported fall towards the earth, but they never thought how wonderful the fact is, considered apart from the familiarity of the experience. Here was a force ever ready to act, acting instantaneously on bodies submitted to its influence, acting really on all bodies, whether falling or not, yet it never occurred to men to ask what such a force might mean. The most insignificant push or pull noted where no such force is looked for attracts immediate attention, and the cause of it is sought for at once. But in terrestrial gravity the constant action of a mighty, ever present, and often irresistible force was observed by all men all the time, yet because it was familiar none cared to ask how it acted or what it imported.

But gravitation, not as a mysterious force residing in the earth's centre, but as a property possessed by matter, is altogether a greater mystery than terrestrial gravity. The universality of the property, which belongs not merely to this or that substance, but to every substance, solid, liquid, or gaseous, and not to such and such aggregations of matter, but to the ultimate molecules and atoms, is an amazing, I might almost say an appalling mystery. Here is matter which men call inert, not merely possessing inherent force, but with its whole texture instinct with inherent unexplained, probably inexplicable power. The absence of all limit of the range of gravity's action through distance is an infinite mystery. Sir Isaac Newton himself, who discovered the law of universal gravitation, was utterly unable to conceive of any way in which "matter could act where it is not." Nay, he expressed his conviction that "no man with a competent power of thinking" (he evidently had his eye on the paradoxists of his day) "could imagine the possibility of matter so acting." Yet the sun acts on the earth, though between him and our world a gulf is set wherein not even thinnest air is present, and he draws the earth constantly towards him. The earth draws the moon. Each orb in space draws every other orb, even across distances so great that light, with its velocity of 187,000 miles per second,

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takes thousands of years in traversing them. Nay, the least particle of dust on the surface of our earth exerts the full measure of its attracting force, duly diminished only according to the law depending on distance, on every particle of matter in the remotest of all the star clouds in our galaxy, and doubtless millions of times farther off in the matter present in other galaxies than ours which no telescope yet made by man has revealed.

But if the universality of gravitation and the infinite range of the force thus exerted by all matter are wonderful, infinitely more wonderful, as it seems to me, is the instantaneous nature of its operation. This quality of universal gravitation is indeed so wonderful that few who hear of it for the first time can even admit that it is possible. Yet the astronomer has been able to demonstrate that the interval of time required for gravity to extend its action from one body in space to any other body, no matter how distant, is less than any interval which can be measured, which is only another way, the correct way, be it noticed, of saying that the action of gravity over any distance, however great, is for us practically instantaneous.

The way in which this was discovered was full of interest. The case was a good example of the modern scientific methods of research :—

It had been observed that the moon's motion was continually growing somewhat quicker than seemed due to the calculated effects due to the actions of the various bodies which act upon her, the sun chiefly, the earth next, and the other planets less, but still appreciably. The discrepancy was very slight. Two thousand years of this then unexplained acceleration of the moon would only throw her disc half a diameter in advance of its place, calculated, as closely as was then possible, from the beginning of that long period. Still, such a discrepancy as that would obviously make a considerable difference in the direction of the moon's shadow on the earth in the time of a total eclipse of the sun ; and it will readily be understood that when astronomers calculated back the moon's position at the time of the earliest recorded eclipses, they found the track of the shadow by no means corresponding with the records left by ancient historians. It was while astronomers were striving to explain the moon's acceleration by re-examining their methods of calculation, that some mathematicians threw out the suggestion that possibly the discrepancy might be due to the circumstance that the force of gravity does not act instantaneously over long distances any more than light does. The great French mathematician Laplace immediately took up this inquiry, not however with much hope that it would explain the moon's acceleration, on which in point of fact it was found to have no bearing whatever. He calculated the effects which would result if the members of the solar system were acted upon by a force emanating from the sun but exerted attractively towards him, and travelling with great but measurable velocity. He found that such an attractive power would not explain the movements of the planets. The whole mechanism of the solar system would go wrong if a force such as this were substituted for the force of gravity. And with the more exact knowledge of the planetary movements obtained since Laplace's day, it may safely be asserted that so long a time as one single second is not required for the transmission of the sun's attractive action to the remote path where Neptune pursues his gloomy course!

Without attempting to follow here the calculations of Laplace, which would be out of place even in a college lecture, I may note one effect which would very obviously follow from the action of gravity if the force required time for its transmission. Suppose the action of gravity transmitted as swiftly as light travels, so that about nine minutes would elapse before the pull exerted by the sun was felt upon the earth. Then the direction in which the pull would be felt would be the same as the direction in which the sun's light seems to fall upon the earth—viz., on account of the velocity with which the earth travels (18½ miles per second) influencing the apparent direction in which light, travelling more than 10,000 times as fast, reaches the earth, a direction inclined more than eight seconds of arc to the true direction of the sun. Hence, besides the attraction towards the sun's centre under whose influence the earth would pursue her oval path unchanged, there would be a thwart pull hastening the motion of the earth around the sun. This thwart pull would only be equivalent to about the ten-thousandth part of of the sun's direct pull, but even so small a fraction as this of a force so large would have an important influence on the earth. Even in the course of a single year the steady action of this accelerating force would considerably modify the earth's motions. But the earth has moved round the sun for more than 2,000 years since the first records of her motions we possess were made, and not the slightest measurable change in her orbit has taken place. It is certain then, even from this comparatively rough test, that the action of gravity must be transmitted many hundreds of times more quickly than light travels. From the much more complex calculations of Laplace, and from his results extended so as to include the more precise determinations of planetary motions made in recent times, it is certain that the velocity with which the action of gravity is transmitted must exceed the velocity of light many millions of times.

FOOTPRINTS OF PREHISTORIC MAN.

By W. H. WESLEY.

AS far back as 1884 it was announced by Dr. Earl Flint that human footprints had been found upon the volcanic rocks of Nicaragua in Central America, and Dr. D. G. Brinton has recently* given an interesting account of these remarkable discoveries.

The region where they were found is one of great geological interest. Nicaragua presents everywhere evidences of volcanic activity on a most extensive scale. Its complicated mountain ranges are marked in every direction with immense lava streams and studded with volcanic craters, many of them still active, while frequent earthquakes attest the continued existence of vast subterranean forces.

Lake Managua, near which most of the discoveries were made, is separated from Lake Nicaragua by a low plain, to the south of which rises a table land on which stand the volcanos of Mombacho and Masaya. Beyond these the land rises to the Sierra de Managua, with Tizcapa and other large extinct craters, while to the north-west, near Lake Managua are the still active volcanos of Chiltepec and Mombotombo. There is a tradition that just before the Spanish conquest an eruption of Mombacho destroyed an important town, while Masaya was active in 1858 and 1872, and Mombotombo in 1852. The lava stream from Masaya in 1872 was no less than two miles wide. In former times the district was the scene of still more violent cataclysms, one of which enclosed Lake Nicaragua, till then an inlet of the sea. Dr. Flint shows conclusively that this marked a period of wide-spread volcanic energy, largely modifying the geography of the region. Twenty miles from the nearest crater the deposit of ashes from the eruption is 15 feet in thickness.

* "Proceedings of the American Philosophical Society," vol. xxiv

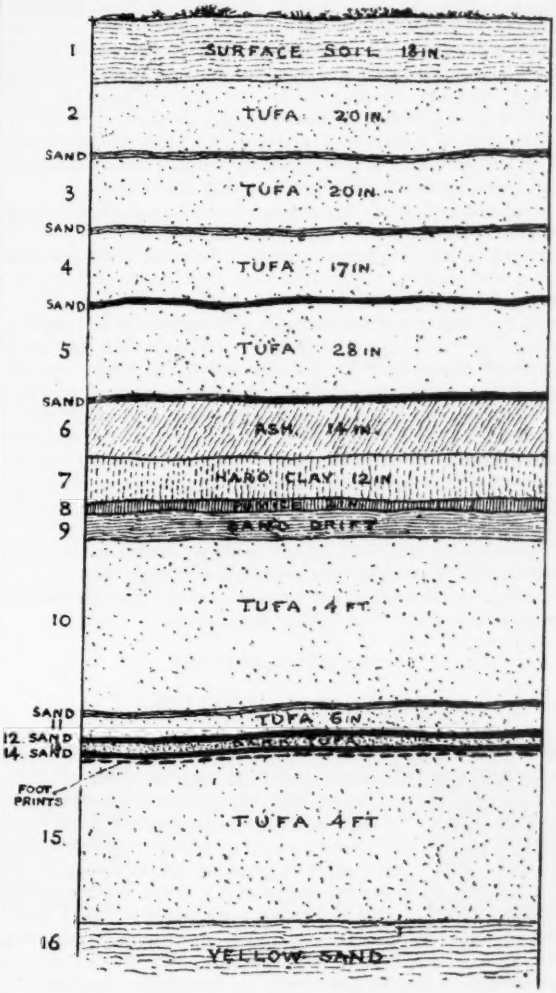
About 2½ miles from Lake Managua is the long since extinct volcano of Tizcapa, whose streams of lava in former ages found their way into the waters of the lake. Its eruptions were evidently irregular and separated by long periods of quiescence, during which the beds of tufa and streams of lava became covered with vegetation, the remains of which are found embedded in the deposits of later eruptions. The immense crater of Tizcapa is now, like the neighbouring extinct volcanos, a lake of silent water: many of these are several square miles in extent, and of unknown depth. Their precipitous walls of tufa are cut through by deep ravines, through which the detritus is being gradually carried back to re-fill the deep abyss.

These lakes have probably not materially changed in appearance since the Spanish conquest, nearly four hundred years ago. The rocks around were covered with inscriptions,

of the origin or meaning of which the tribes then inhabiting the region had not even a tradition. Time has disintegrated the tufa wastes, upon which dense forests are now growing. Below this fertile soil are five well-marked beds of tufa, separated by layers of sand. We then reach a deposit of ash, and then a layer of clay a foot in thickness, which seems to have been deposited under circumstances similar to those which prevail at the present time. It contains numerous impressions of leaves, and bones of the mastodon. Beneath this are seven more deposits of sand, tufa, pumice, and ash, and then a deep bed of tufa, on which, 21 feet from the surface, the human footprints are found. They are in great numbers, passing to and from the lake shore, some sinking deep and some leaving but slight impressions; now and then treading a leaf into the once plastic surface. This tufa lies on a bed of yellow sand—possibly eocene—of undetermined thickness, containing numerous small shells of the genus *Pyrula*.

The longest of the footprints measured 10 inches; the specimen of which a figure is given (copied from the plate illustrating Dr. Brinton's paper) is 9½ inches long, the breadth of the foot across the toes 4½ inches, and at the heel 3 inches. The foot corresponding to this impression was probably about 8 inches in length, and appears to have been well shaped, with a great toe slightly longer than the second toe. It need hardly be mentioned that the latter is a somewhat important race-character, a long great toe (being further removed from the ape type) showing a higher stage of development. All the footsteps at Managua are those of bare feet, but others were found by Dr. Flint on the southern slope of the Sierra de Managua, one of which was that of a foot protected by some kind of sandal or mocassin. In this case the tufa had been covered by detritus, which rivers have since been removing seaward, disclosing the footprints on the earlier deposit.

Of course the importance of these discoveries entirely depends on the antiquity which can be ascribed to them.



That the traces are human is beyond question, but how old are they? Unfortunately the shells found in the underlying bed of yellow sand were of only one species, and do not

appear to the geologists who have examined them to afford direct evidence of the age of the deposit, which Professor Heilprin inclines to consider Post-pliocene rather than Eocene.

At first sight, no doubt, the great number of the deposits overlying the footmarks seems evidence of enormous antiquity, and it certainly is an important consideration. But it must be remembered that these layers are mostly of volcanic origin, and need not, therefore, demand any great length of time for their deposition. Still, while each bed may have been rapidly deposited, the different beds are well marked, and mostly separated by seams of sand, which almost certainly indicate that they were caused by *successive* eruptions, which might have been separated by considerable periods of time.

The deposit of hard clay (No. 7) must certainly indicate a prolonged period of repose. Although its depth is not great where the section is taken, in other localities it increases in thickness to 10 or 12 feet, and it contains bones of the mastodon and numerous leaves, showing that vegetation had time to accumulate. The mastodon remains, however, as Dr. Brinton has pointed out, are no evidence of great antiquity, as the animal existed in tropical America almost in historic times. A complete skeleton of one was found not long ago in an artificial salt pond constructed by the Indians; a landslip having buried the pond, with its paved bottom, together with the mastodon. The ash deposit of 14 inches thick (in other parts as much as 15 feet) is that which Dr. Flint considers to mark the period of enormous volcanic activity, when Lake Nicaragua, and probably also Lake Managua, were enclosed.

With regard to the discoveries on the slopes of the Sierra de Managua, evidence of equal weight as to the antiquity of the human traces is found, and Dr. Flint considers them to prove indisputably the existence of man in Pliocene times. Still we must recollect that in such an active volcanic region as Nicaragua, with its hot and moist climate, sudden upheavals and subsidences may be expected to have occurred, while the rich tropical vegetation would rapidly repair the ravages caused by the most devastating eruptions.

The footprints themselves tell us little as regards their antiquity. As before mentioned, they present no evidence of belonging to an inferior type of man, while the sandal-shod footprint indicates a certain advance in civilisation, since a man who wears shoes at all can hardly belong to the earliest stage of human culture. Considering all the circumstances, therefore, it will, perhaps, be wisest to adopt Dr. Brinton's cautious conclusion, that there is not sufficient evidence to remove these remains further back than the present Post-pliocene or Quaternary period.

PREHISTORIC METALLURGY.

By W. Mattieu Williams.

THE most interesting chapter of the geologic chronicle, that which records the entrance of man upon the earth, his primitive condition and progress, was unopened 50 years ago. It was blank within the reach of my own remembrance, i.e. when I attended the class of Professor Jamieson in the University of Edinburgh in 1841. We were merely told that no human fossils had been reliably discovered, and our textbook, exactly 50 years old ("A Treatise on Geology," by John Phillips, F.R.S., G.S., Professor of Geology in King's College, London, &c., 1838) says, page 193, "As far as direct observation or satisfactory inference goes, every honest geologist will allow that he is ignorant of the point of union between the historical and geological scales of time: that the era of human existence, if recorded in geological monuments, has not yet been discovered among the small number which have been fully deciphered."

Since this was published remarkable progress has been made. Not only have human remains been found among those of animals that are now extinct, but we are able to trace his slow progress in the primitive arts of humanity, and in his early adaptation of the materials and forces of nature to the supply of his wants. We can even contemplate the growth of his mechanical skill and artistic taste during periods that vastly preceded the earliest ages of carved or written historical records or surviving oral tradition.

His remaining implements and weapons have chiefly supplied the information. At first he used only what he could pick up on the surface of the earth, sticks, stones, horn, bones and shells. This period has been styled the stone age, and has been divided into palæolithic and neolithic, the older and later stone ages.

I must not dwell upon any particulars concerning these, but proceed to that of my immediate subject, viz., the stage which followed this. I prefer the term *stage* to *age*, for reasons to be stated presently.

This is the age or stage of metals, usually divided into the bronze period and the iron period, the bronze preceding the iron. The fact that bronze did precede iron is demonstrated by the fact that wherever both have been found, the bronze exists among the relics of greater antiquity. It is true that some very ancient vestiges of iron have been discovered, more ancient than some other and *distant* remains of bronze, but the precedence when justly claimed (which is not always the case) is rather a precedence of order than a precedence in positive time.

Thus, at the present moment the savages of New Guinea are in the stone period; they still use flint implements. In their case the intermediate or bronze period will doubtless be omitted, as they are already obtaining iron and steel from outside, just as the Guanches of Teneriffe, who were highly developed, remarkably advanced neolithic people, even using stones for shaving, knew nothing whatever of metals when discovered and slaughtered by the Spaniards between 1402 and 1496. (See paper by Mr. J. Harris Stone, read before Anthropological Section, at the last meeting of the British Association.) The uses of steel were cruelly taught at once, without the intermediate bronze.

As such variations of position and circumstance have modified the prehistoric progress of man, I prefer the use of *stage* to *age*, and shall use the word accordingly.

Are there any natural chemical or mineralogical reasons why in the primitive and undisturbed evolution of human civilisation bronze should have preceded iron?

I think there are, and will state my reasons. It is certain that neither could have been used before the invention of fire, which, by the way, I will venture to suggest was naturally connected with palæolithic implement making. In striking off the splinters of flint great heat must have been evolved, and thus the idea of artificial generation of heat would be suggested.

Now let us suppose that Cornwall or any other country of similar geological formation were inhabited by neolithic men who had learned the use of fire, and had advanced sufficiently to make such rude pots of baked clay as are found associated with neolithic implements. There is abundant reason to conclude that they used the primitive device of boiling water by putting hot stones into these pots, as they could not stand heating from outside for this purpose.

Among the rolled pebbles of the sea beach and the river

banks of Cornwall were many of a grey colour, as stony in appearance as any of their neighbours, but nevertheless composed of nearly pure oxide of tin. They must have been very abundant then, as three thousand years of collecting have not yet exhausted these superficial deposits. What would happen to these stones when heated in a wood fire?

Evidently the same as occurs when they are similarly treated in our modern smelting furnaces, where they are simply exposed to the reducing action of heated carbon. The heated carbon and hydrogen of the wood fire would combine with the oxygen of the tin-stone, and a button of silvery metal would be found among the wood ashes, as anybody may prove by thus treating a pebble of Cornish tin-stone.

But in Cornwall and other places there are other metalliferous pebbles lying side by side with the tin-stones, notably copper pyrites, which, when thus heated in contact with incandescent carbon is roasted and reduced, though at a higher temperature than is demanded for the tin. Thus all that was required for the accidental discovery of bronze was that one or more of each of these metalliferous pebbles should be mixed with the other pebbles in the fire, where they would be reduced to metal, be melted, and then would run down to the lowest part and alloy themselves together, forming the gold-like bronze which could not fail to attract the attention of the rudest savage and provoke him to investigate its properties.

This investigation of the mysterious child of fire would be further promoted by its unexpected creation by the first object of primitive human worship, the power of heat. To him the metal would thus appear as a direct gift from the divinity of his adoration.

Presently he would learn to beat it into shape, to melt and cast it, to make it harder or softer according to its rate of cooling. Having made this discovery of such variability of hardness, he became possessed of a material that added enormously to his power over the physical materials of the world, i.e., a material for tools; also to his power over the beasts around him, and his human enemies, i.e., a material for weapons—a material that could fashion itself, which in its hardened state could cut and beat out the same material in its soft condition, a tool that could make other tools similar to itself.

The manufacture of this must have long continued and have greatly developed before the difficulties of producing iron and steel could be mastered. It was necessary for this that something of the rationale of the primitive discovery should be discovered, and the raw materials should be deliberately selected and their proportions adjusted. It was also necessary that the effect of a blast on combustion should be understood, and some kind of bellows invented, as this is necessary for the smelting of iron ores.

These steps having been taken, only one more was needed. Side by side with the copper pyrites, much more abundant, and also more widely diffused, was another bright yellow mineral scarcely distinguishable from it. This placed in the primitive fires without blast, would merely lose its golden lustre and become a black and earthy, but very heavy stone, that could not be melted. But on the application of a strong blast this would fuse and produce a grey metal, still harder than the hard bronze.

This amount of knowledge once acquired, other stones resembling the dark roasted pyrites would be discovered and recognised by their resembling colour and density. These are the native magnetic oxides of iron, the abundant raw material of all the primitive ironmasters, ancient and modern.

This brings me to another conclusion, that to some may appear rather heterodox, viz., that steel was discovered and used long before iron. The effect of using the primitive material and the primitive fuel, urged by a primitive blast, must of necessity be the production, not of refractory iron, but of a compound of iron with the carbon of the fire, a far more fusible and more manageable material, varying, however, through a considerable range of hardness and fusibility, according to the proportion of combined carbon.

As a matter of fact, we still produce steel more easily than iron. Our common white pig iron is a steel, but one of great impurity, owing to our use of far more impure materials than those of the primitive makers.

Long after this first stage of steel making, came the primitive "bloomeries," in which wrought iron was made, but which I must not here stop to describe.

The primitive steel would naturally be treated like the bronze. Its variations of hardness, when slowly or suddenly cooled, would be investigated by those familiar with the changes thereby effected upon bronze, and thus a new and most important era in the physical progress of the human race would be opened, by his possession of a material possessing the property of varying hardness belonging to bronze, but in such an exalted degree that the steel itself could be cut and shaped by steel as easily as wood could be shaped by bronze, and which in its hardest condition could master all things except the hardest flints, and even strike fire by collision with them. It can, moreover, be tempered into every intermediate degree of hardness by a device so simple that no keen-eyed observing savage could fail to discover the mode of doing it.

I should add to the above that the earliest history records the visits of Phœnician merchants "to the land of tin," i.e., to the south-west extremity of Britain—to Cornwall; where tin and copper pyrites are so remarkably distributed together on the surface. Recent archæological researches indicate that in some places copper preceded bronze. This is to be expected, as copper pyrites is much more widely distributed than tin-stone.

Also my belief that the first metal discovered by man was gold. This conclusion is founded on the fact that gold is one of the most widely diffused of all the metals; there is scarcely any part of the world where it may not be found in small quantities, and upon the surface, i.e. in river sands. It is always found in the metallic state, not as an ore requiring to be smelted, and so malleable that it could be beaten into any shape by stone tools. Ornaments of gold have been found among some of the flint and bone weapons and implements of the stone stage of human progress.

It is too soft to serve any other purpose among such people than that of ornament, and we know that the most primitive of our fellow-creatures love ornament. All savages are artistic.

COMMON SALT.

By GEORGE MCGOWAN, Ph.D.
Demonstrator of Chemistry in the University of N. Wales.

COMMON salt, also called sea salt, or muriate of soda, and termed in chemical language chloride of sodium, is one of the most widely diffused substances known. We find it in rocks, in the soil, in all waters, and in minute quantity in the air.

1. As *rock salt* it occurs in layers varying from less than an inch to more than 600 feet in thickness; at Stassfurth, in North Germany, the beds of it have a thickness of 685 feet.

Rock salt is found in the most recent geological formations, as well as in those of great antiquity, being generally associated with gypsum and beds of clay. The principal deposits in this country are at Northwich in Cheshire and

Droitwich in Worcestershire, both in the new red sandstone formation, and among many others may be mentioned the Stassfurth beds already referred to, the Salzburg mines in the Eastern Tyrol, and the famous mines of Wieliezka in Galicia, which last are of enormous magnitude. The Cheshire deposit consists of two beds separated by 30 feet of clay, the two together being 60 feet thick, 900 feet broad, and 1½ miles long. Owing to its ready solubility in water, rock salt is never found on the surface of the soil in moist climates. With regard to its formation, there can be little doubt that the beds of it are deposited from the evaporation of very salt water in enclosed basins, a process which is going on at present in the Dead Sea, the Great Salt Lake of Utah, &c. The other salts present in sea water are, speaking generally, either much more or much less soluble than common salt, which accounts for the purity of rock salt. In the Stassfurth deposits the different salts are found super-imposed upon each other in the order of their respective solubilities.

Rock salt is beautifully crystalline, the crystals when perfect having the form of cubes. When pure it is colourless and transparent, but it is sometimes coloured red by a minute animal belonging to the class known to zoologists as the *Infusoriæ*, which is found inhabiting salt lakes at the present day; it is sometimes also coloured green or blue. When impure, its chief impurities are gypsum and oxide of iron; sometimes also other salts of calcium, magnesium and potassium.

2. Besides occurring in beds as rock salt, salt is frequently met with impregnating the surface soil in *dry* climates. It is further found diffused in comparatively minute quantity through all rock strata.

3. *Salt in sea water.* The sea covers about three-fourths of the surface of the globe, and, according to the recent observations taken in the *Challenger* Expedition, the Atlantic and Pacific Oceans have an average depth of 2 to 3½ miles, although in the Pacific soundings were got deeper than 5 miles. Since sea water contains about 2·7 per cent. by weight of common salt, the total quantity of the latter present in it is enormous. Thus, taking the average depth of the Atlantic and Pacific at 2¾ miles, there is in the water underneath every square mile of its surface 312,850,000 tons of salt.

The method of obtaining salt from the deposits varies according to the locality, the warmth of the climate, and the price of fuel. Rock salt itself is rarely of sufficient purity for household use. Sometimes it is mined, and here it may be mentioned that the air in salt-mines is usually exceedingly dry, so that the miners are even apt to be incommoded by the salt dust: but more frequently artificial brine springs are constructed by boring through the overlying strata to the salt bed, and allowing water to flow down on to it. When the water becomes saturated with salt, it is pumped up and evaporated. The shafts of the mine are lined with iron or wooden casings, to prevent the inflow of fresh spring water. Sometimes such brine springs occur naturally, although in this case they are for the most part but slightly impregnated with salt.

At Berchtesgaden, near Salzburg, in the Eastern Tyrol, a large subterranean lake has been formed, the water of which is saturated with salt. Over this lake visitors are ferried in their journey through the mines, and are naturally reminded, by the gloom of the huge cavern, whose darkness is rendered only the more apparent by the feebly-glimmering lights of the miners, of Charon and the river Styx.

The method of evaporation followed is the simplest possible. At Droitwich, for instance, where salt has been manufactured from the time of the Romans, the saturated brine—containing 22½ per cent. of common salt—is run into long shallow iron tanks, which are heated by flues connected with furnaces at one end. The salt soon begins to crystallise out, and is transferred from the pan and pressed into a rectangular wooden mould with a perforated bottom. The block of salt thus obtained is finally dried for some time in a hot-air chamber. One ton of salt requires for its production 10 cwt. to 12 cwt. of small coal or slack. The pans have to be cleaned out from time to time, to get rid of the incrustation of gypsum which deposits at the bottom, and which is valuable as a manure. In the year 1876, 2,118,000 tons of salt were obtained from English brine, besides 154,000 tons raised as rock salt. The size of the grain of the salt depends entirely upon the temperature and upon the rapidity of crystallisation.

With regard to crystallisation from solutions generally, if the evaporation of the liquid is gradual, and the crystallisation therefore slow, large crystals are deposited, and *vice versâ*. Thus, in salt-evaporating pans, fine-grained salt is formed at the end near the fireplace, coarse or "bay" salt at the far end, and a salt of intermediate size of grain, "common salt," in the middle.

In countries such as France and Germany, where fuel is dear, the weaker salt springs and sea water are first concentrated by a process called "graduation." In this process the brine is pumped up to a large cistern on the top of a tower, and allowed to trickle slowly over large stacks of fagots or thorns, screened from the rain by suitable buildings, but freely exposed to the prevailing wind. In its descent it thus becomes concentrated by evaporation of the water, and, after the process has been repeated some eight to ten times, and the brine reaches a density of 1·14 to 1·16, the evaporation is concluded by artificial heat. At Salza, near Schönebeck, the graduation house is more than a mile long, the thorn walls from 33 feet to 52 feet high, and the total surface exposed 25,000 square feet. At the bottom is a wooden cistern for receiving the concentrated brine. The twigs gradually become coated with gypsum, and have to be removed from time to time. It has been calculated that in ordinary weather 13 gallons of water are evaporated from every square foot of surface in twenty-four hours.

The evaporation of sea water in the old "salterns" or brine pans, by the aid of the sun and wind, is still carried on to some extent in this country, for instance, at Lymington in England, and at Saltcoats in Scotland. In France and Spain, where the sun's rays are stronger, these salterns are more frequently to be met with. It is interesting to note here how an ancient industry is commemorated to posterity in the names of places, witness the name Prestonpans, in Haddingtonshire, famous in history for the battle there in 1745, in the second Stuart rising. Many other instances of the same kind might be given.

On the coasts of the Mediterranean Sea water is evaporated in what are known as "salt gardens." These are large basins or pits built of clay, and stretching along the seashore. They are in communication with a reservoir, which is filled with sea water at high tide. These brine pits are divided into a number of compartments, separated from each other by small banks, and through them the sea water slowly flows, being exposed to the wind in its progress. In this way it gradually becomes concentrated, until finally, in the last brine pits, the salt crystallises out.

In Siberia, Sweden and other northern countries, advantage is taken of the fact that when sea water freezes, fresh-water ice separates out, leaving a strong saline solution behind. This brine is then boiled down for salt which, however, is not obtained very pure by this process. We have thus, in the manufacture of salt, a striking instance of the diverse natural capabilities of different countries being made use of to achieve the same end; in warm countries the heat of the sun is the agent, while in cold countries the cold itself is utilised.

Common salt is, in chemical language, chloride of sodium, i.e. it is composed of the two elements, sodium and chlorine. That this is so is easily proved by simply burning metallic sodium in moist chlorine gas, when salt is formed.

Salt is somewhat peculiar in being nearly as soluble in cold water as in hot.

The uses and applications of common salt are so numerous that they cannot all be even mentioned within the limits of this article. Its preservative and antiseptic properties are well known to everyone. It is the ground material for our largest chemical manufacture, that of soda. Rock salt permits rays of heat to pass through it unabsorbed just as window-glass does the rays of light, and it is therefore largely used in physical laboratories in experiments upon heat.

There are many people who imagine that they never eat salt, but remain strong and healthy without it. This, however, is a delusion on their part because, although they are not conscious of eating it directly, they do so indirectly, seeing that salt is present naturally in the material of every food which we eat, whether animal or vegetable; it exists alike in corn and flesh of all kinds. Salt, when pure, has not much taste, and is only slightly bitter. Ordinary table salt owes its sharp taste to the presence of a small quantity of chloride of magnesium, which is invariably found in all salt of commerce, and can only be got rid of by special methods. To the presence of this substance is also due the fact that salt very readily becomes moist. Every good housewife knows how to test the dryness or dampness of a cupboard by allowing some salt to remain in it for a few days. It is, again, the chloride of magnesium in sea water which prevents one's hair from drying readily after bathing. Chloride of magnesium has an intense affinity for water, and wherever it is present it abstracts the moisture from the surrounding air, becoming itself damp in so doing. Everyone has heard of travellers bathing in the Dead Sea, in which they could not sink. But the same luxury can be enjoyed much nearer home. At Droitwich, near Worcester, where brine baths are now being largely taken advantage of, and with very good effect, for rheumatic complaints, there is a swimming-bath filled with pretty strong brine at a pleasant temperature. The water is so strong that the most timid bather need never be afraid of sinking below his shoulders. The writer would, however, warn any intending bathers there not to dive in head-foremost at the deep end of the bath, but to walk cautiously in from the shallow end, never allowing the head to go under water; if this precaution be not observed, the effects on the breathing and on the eyes will be more striking than pleasant.

By means of the spectroscope it is now possible, as Bunsen has shown, to detect with accuracy the presence of $\frac{1}{18000000}$ part of a grain of salt.

OLD MUSEUMS.

I.—THE ASHMOLEAN, OXFORD.

TO the Dutch gardener of Charles I. and his Rose and Lily Queen * our nation owes its earliest museum. For in the term museum we do not include collections of works of art like the Vatican or that of Lord Arundel, which Evelyn, in pity for their neglected state, successfully begged might be more safely deposited at Oxford. The oldest museum we know of was one which Ptolemy Philadelphos founded at Alexandria in 282 B.C., as a place of study, and which he further furnished with numerous literary and scientifical volumes.

John Tradescant, or rather Tredescant, a Hollander, and long time servant to Lord Wootton and Lord Treasurer Salisbury, settled at Lambeth. There he laid out his "physic"—what we now should term botanical—"garden," and arranged the specimens that he had gathered during his travels in Europe, including Muscovy, in Barbary, and the Mediterranean islands. He lived in what was vulgarly styled "Tradeskin's Ark," on the east side of the later South Lambeth Road, receiving there many learned men of the day, until his death in 1638, having been appointed "King's gardener" in 1629.

His son John, who inherited his father's tastes and office, brought several plants and herbs from Virginia. By will dated April 4, 1661, and proved by his widow Hester in 1662, he gave his "closet of rarities" to her for life, and then "to the Universities of Oxford or Cambridge, to which of them shee shall think fit at her decease." On April 3, 1678, Hester Tredescant was found drowned in the garden pond at South Lambeth. Meanwhile Elias Ashmole, friend and intimate of the Tredescants, had set up a claim to the museum. In his diary under date December 15, 1659, he records that it was given to him by John Tredescant and his wife Hester. The dispute became matter of a lawsuit, in respect whereof it will be enough to say here, that Lord Chancellor Clarendon decided Ashmole to be proprietor of the goods subject to the trust for the defendant during her life. The curiously ornamented tomb of the Tredescants, erected by Hester, in St. Mary's, Lambeth, churchyard, was restored in 1773, and again, by public subscription, in 1853, promoted by the late Sir William Hooker.

Elias, son to Simon Ashmole, a saddler and loriner at Lichfield, was born, as he painfully records, near thirty minutes after three on the morning of May 23, 1617. When sixteen years old he entered the household of James Paget, a baron of the Exchequer, who had married the sister of his mother, Anne Boyers. Under his uncle he studied law, and in 1638 began life as solicitor in Chancery. He became successively an attorney of the Common Pleas (1643), gentleman of ordnance to the royal forces at Oxford, 1645, when he entered of Brasenose, an officer of the newly-established excise, and comptroller of ordnance. In 1647 he retired to Englefield, in Berkshire, where he applied himself to botany. Two years later he took for his second wife the wealthy widow of Sir Thomas Mainwaring and daughter of Sir Thomas Forster, being her fourth husband. At first devoted to alchemy and astrology, he in 1650, having removed to London, published various unprinted works by English chemists, with, under name of "James Hasolle," a treatise on Dr. Dee's philosopher's stone—a bit of cannel coal, "the devil's looking-glass" of Kelly, Dee's associate, mentioned in "Hudibras," ii. c. 3—and which was sold at Christie's on July 14 last, amongst Lord Londesborough's collection. In 1652 he began to learn Hebrew that he might master some books on the occult sciences. Yet he cultivated the more beneficial studies of medicine, anatomy, chemistry, botany, and heraldry. He was for awhile engaged in surveying the Fen country with Dugdale, whose daughter Elizabeth he married, for his third wife, in Lincoln's Inn Chapel, on November 3, 1668. Eight years previously he had been appointed Windsor Herald, called to the bar, and elected F.R.S. Succeeding to the Tredescants at Lambeth, he enlarged the house, and made some considerable additions to its contents, though he had lost much of his possessions, including some ancient and modern coins, &c., by a fire at his Middle Temple chambers in 1679.

* These cognisances of Queen Henrietta Maria were once more common than they are now. They have, however, remained to our own day upon the fronts of one or two of the houses (Arch Row) as built by Inigo Jones in Lincoln's Inn Fields.

His gift to Oxford was made in 1682. In 1692 he died, and was buried in Lambeth Churchyard. The old house at Lambeth, since known as Turret House, together with its historic garden, was pulled down seven years ago, and the site appropriated for building purposes. A view of the house, as distinguished by its fine iron gateway, may be found in the "Fauntleroy" Pennant at the Soane Museum. Its site and former name are commemorated by the modern Tradescant Road.

Ashmole's original museum at Oxford, housed in a building designed by Sir Christopher Wren, was subsequently enriched by many additions. These comprised the Aubrey, Anthony Wood, and Dugdale MSS., Martin Lister's collections of shells and fossils, Lloyd's, Borlase's, and Dr. Plot's natural history preparations, together with various specimens of tools, instruments, and clothing from different parts of the world, more or less civilised. Here is preserved the Alfred gem, an enamelled jewel found in 1693, at Newton Park, near to the site of a monastery which Alfred established at Athelney, co. Somerset, and which is supposed to have belonged to the king's staff or sceptre. Dr. Rawlinson endowed the curatorship, and some sixty years since the contents of the museum, long neglected, were classified and rearranged, at a time when the study of natural science at the University had received a new impulse from the lectures of Buckland on geology and of Dr. Kidd upon comparative anatomy.

THE LICK OBSERVATORY.

IT is now fourteen years since James Lick placed in the hands of a Board of Trustees the sum of 700,000 dollars for the purpose of erecting "a powerful telescope, superior to and more powerful than any telescope yet made." So many delays were met with and so many difficulties had to be overcome, that only during the present year has the observatory really commenced its work.

James Lick was born in 1796 at Fredericksburg, Pennsylvania. An organ and pianoforte-maker by trade, he carried on his business in Baltimore, Philadelphia, and Buenos Ayres, finally settling in San Francisco in 1847. Successful land speculations enabled him to amass a fortune of some 3,000,000 dollars, which was all left for public purposes. He appears to have had a strong desire to perpetuate his memory, and at one time entertained the idea of erecting, on the shores of San Francisco Bay, a pyramid of marble larger than that of Cheops. Fortunately he was restrained from this foolish project by the fear that in case of a war the pyramid might perish in a possible bombardment, and the observatory took the place of the pyramid. Disagreements arose between Mr. Lick and the trustees, leading to the resignation of two boards in succession. A third set of trustees was chosen in 1876, when Mr. Lick died, and serious legal difficulties arose, which were not disposed of till 1879, when the work on the observatory was really commenced.

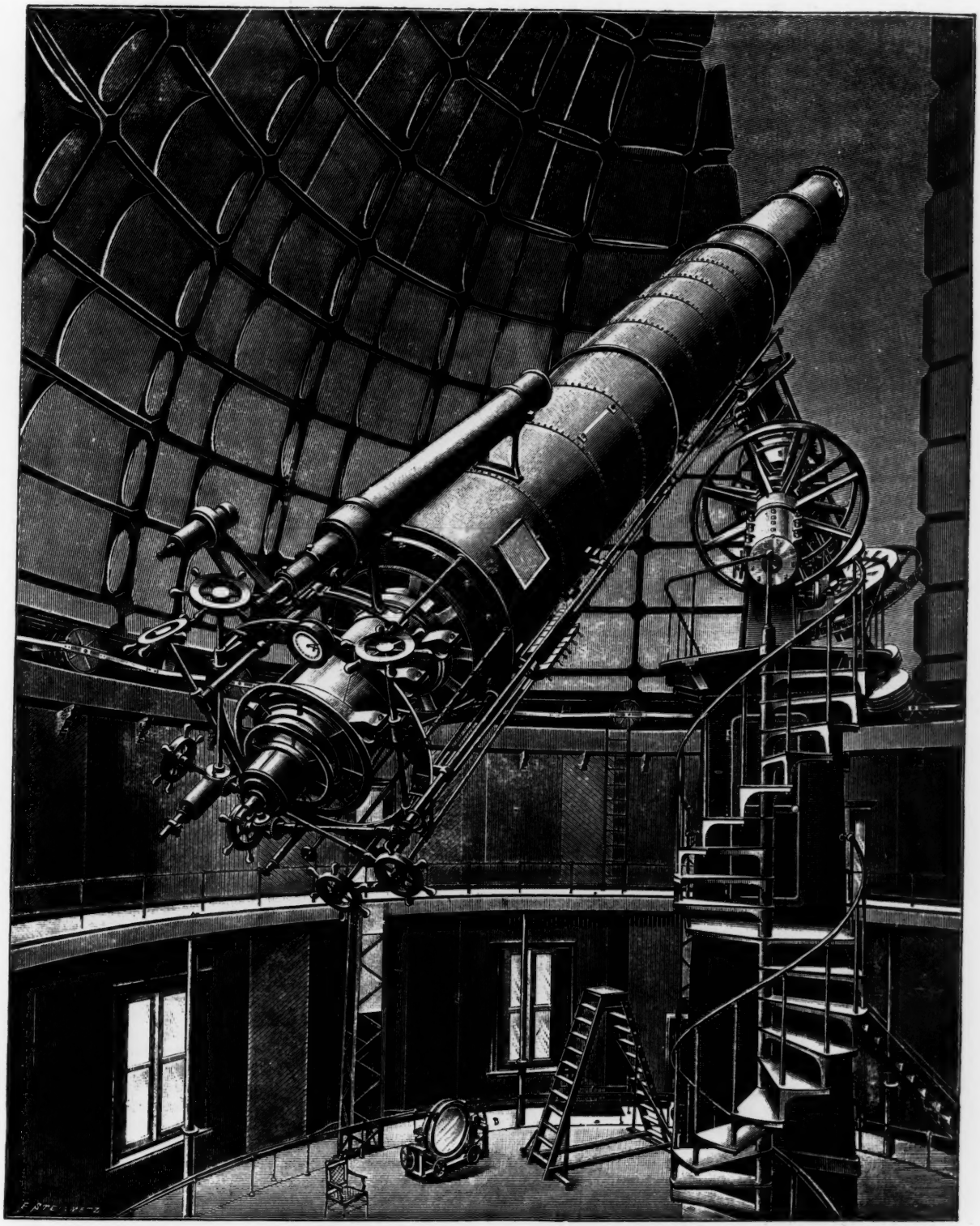
Mr. Lick had, in his first deed of trust (1874), designated a site for the observatory upon some land of his own, near lake Tahoe, California, but this was abandoned on account of the great severity of the winters, and Mount Hamilton, about 60 miles to the south-east of San Francisco, was finally selected, the site being granted by an Act of Congress in 1876. To test the freedom of the atmosphere from the tremors which so much interfere with the definition of telescopes, especially those of large size, Mr. S. W. Burnham, the well-known double-star observer, visited the site in 1879. He took with him a 6-inch telescope, with which he observed on Mount Hamilton during August, September, and part of October. His report was a most satisfactory one, for out of a period of sixty days he found forty-two nights "first class," seven nights "medium," and only eleven cloudy or foggy. His observations were principally confined to the measurement of double stars, and in his report to the trustees he says that some of these observations were remarkable, considering the difficulty of the objects with much larger apertures in other localities; he was confident that μ *Herculis* and *a Capricorni* had never been seen before with so small an object glass. In the daytime the definition was not specially good, and it has since been found that this is also the case in winter, showing that, as Professor Holden observes,* "the secret of the steady seeing at Mount Hamilton lies in the coast fogs. These roll in from the sea every afternoon in summer, rising 1,500 to 2,000 feet; they cover the hot valley, and keep the radiation from it shut in. There are no fogs in the daytime and few in the winter." The fogs seldom reach the summit, which is 4,200 feet above the sea level.

Before this it had been decided that the great telescope of the Lick Observatory should be a refractor, and in 1875 Professor Newcomb paid a visit to Europe to find where suitable glass discs of large size could be procured. It was necessary, in order to carry out the provision of the deed of trust, that the diameter of the object glass should exceed that of any telescope in existence, and should therefore be more than 30 inches, which was the aperture of the Pulkowa telescope, just made by Alvan Clark. It was finally determined that the Lick object glass should be 36 inches in diameter. The extreme difficulty of procuring suitable discs of such an immense size caused long delays: the flint glass (concave) lens was obtained from M. Feil, of Paris, in 1882, but the crown glass (convex) lens was not successfully cast till 1885, after nineteen failures. A second crown glass disc was obtained from M. Feil, in 1886, for a photographic lens, but this broke while being worked, and was replaced by a new one in 1887. The lenses have all been worked by Alvan Clark, and the mounting has been constructed by Warner & Swasey.

It is not possible in a limited space to give any sufficient description of this huge equatorial telescope. The illustration will convey some idea of its general appearance, but as it has been copied from a photograph, necessarily taken from a very near point of view, the perspective is much exaggerated, so that it does not appear properly balanced. The tube is 57 feet long, and nearly cylindrical, with an arrangement for removing the visual and substituting the photographic lens. When used for photography, a fine 12-inch telescope (formerly belonging to Dr. Henry Draper), which is also mounted in the observatory, can be readily attached to the great equatorial as a pointer. The regular finders are of 6, 4, and 3 inches aperture. The distance from the base of the iron pier to the centre of motion is 37 feet 10 inches. The eye end is arranged so that the micrometer can be removed and two steel bars inserted in bearings which form part of a jacket which revolves round the eye end, and to which spectroscopes, photometers, &c., can be attached, so that the telescope can be readily adapted for micrometric, photographic, or spectroscopic work. An observer at the eye end can clamp or give slow motion either in declination or right ascension, stop the clock, and read the circles, while an assistant on the balcony below the axes can also give rapid motion either in right ascension or declination.

The dome for the 36-inch refractor is 75 feet 4 inches in outside diameter: it stands on a circular brick wall, which

* "Handbook of the Lick Observatory."

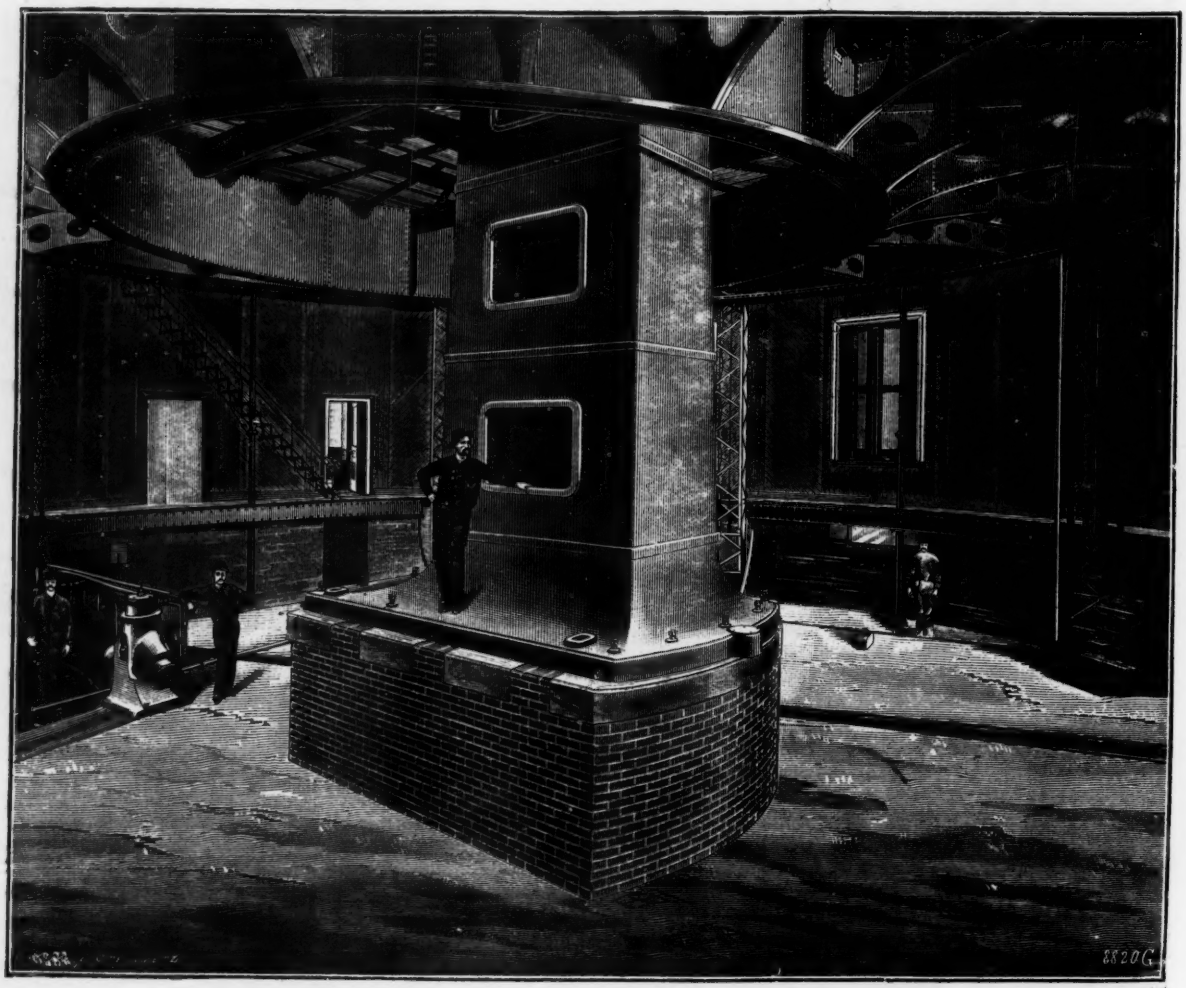


THE GREAT 36-INCH EQUATORIAL OF THE LICK OBSERVATORY.

XUM

rises 35 feet above the ground outside. Its design was very carefully considered with regard to its stability in its exposed position on Mount Hamilton, where the wind at times blows at the rate of seventy or eighty miles an hour. The entire moving parts weigh nearly 89 tons, and are moved by a water-engine, which can rotate the entire dome in less than nine minutes. The bed-plates for the track upon which the dome revolves are constructed to allow for expansion (which amounts to 1⅛ inches in the entire circumference) through changes of temperature, and a smooth surface is provided for the sliding in and out which this

12-inch equatorial before mentioned, another of 6½ inches, and a comet-seeker of 4 inches. There is also a photo-heliograph, a fine meridian circle, and a universal instrument, the two latter by Repsold of Hamburg, and also clocks, chronographs, &c., as well as meteorological and seismological apparatus. The funds at the disposal of the trustees did not permit any large expenditure upon a library, but a suitable room was fitted up for the purpose, and about two thousand volumes which were indispensable for the work of the observatory were purchased. It is hoped that in time the number of books will be greatly increased.



Hydraulic Machinery for Lifting the Floor of the Great Dome.

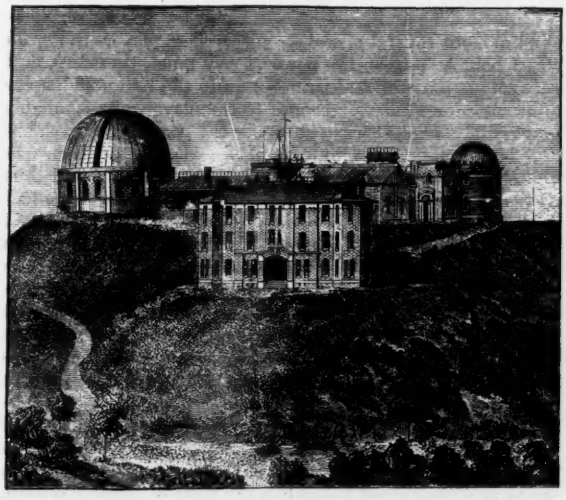
causes, oil being forced between the bearing surfaces by turning a screw. But the most novel feature of the dome is the floor, which is made to rise and fall so as to be always at a suitable height for an observer at the eye end of the telescope. This excellent arrangement was suggested by Sir Howard Grubb, whose proposals were carried out by the trustees. The moving floor is 61½ feet in diameter, and weighs 50,000 lbs., which is nearly all counterpoised; it is raised and lowered by four hydraulic rams. It can be easily raised in nine minutes. The engraving gives an internal view of the dome, taken below the elevating floor.

Besides the great refractor, the observatory contains the

The general appearance of the observatory is shown in the engraving, which is taken from the north-east. At the south end is seen the great dome for the 36-inch equatorial, and at the north end the 25-foot dome for the 12-inch. These domes are connected by a hall, 190 feet in length, along the west side of which are studies, work rooms, &c. When the needs of the observatory require it, a corresponding series of rooms can be built along the east side of the hall. The meridian circle, transit, heliostat, &c., are in detached buildings, as are the astronomers' residences which are shown in the foreground. The observatory itself is a one-story building of painted brick, made from clay found

near the summit, and is roofed with slate, but tin has been found preferable, and has been used for roofing the detached buildings.

The nearest town is San José, thirteen miles to the west of the observatory. In order to lessen the steepness of the ascent, the road, which was constructed by the local authorities, winds over twenty-six miles. The situation is most picturesque, giving views over a wild and rugged country, from the sea on the west, eighty-seven miles, to the Sierras on the east, 130 miles distant. Professor Holden, in his excellent handbook, to which we are indebted for most of these details, gives full instructions for intending



GENERAL VIEW OF OBSERVATORY.

visitors, to whom unusual facilities are given for inspecting the observatory, and arrangements are even made to permit them, at certain hours on one evening in the week, to look through the great equatorial.

This telescope will, from its great light-gathering power, be admirably adapted for observations of nebulæ, upon which important researches are now being carried on; some of these have already been published in the "Monthly Notices" of the Royal Astronomical Society. For photography, which is undoubtedly the astronomy of the future, the great telescope is especially fitted. Its photographic lens, of 33 inches aperture and 550 inches focus, is six times more powerful than the 13-inch refractor at Paris, with which the MM. Henry have already produced such splendid results. The image of the sun or moon in the focus of the great photographic objective is rather more than 5 inches in diameter,* so that sun-spots and details of the lunar surface may now be photographed on a scale hitherto impossible. Photographs of the planets may be taken on a scale sufficient to show many of the smaller details of their surface, for which we have hitherto had to depend upon eye drawings alone. With regard to stellar photography, a single exposure will give a picture of the sky comprising four square degrees, on a plate 22 inches square, upon which a few minutes' exposure will impress the images of all stars visible in even the largest telescopes.

In strict accordance with the terms of the trust deed, the great telescope has properly been made the important feature of the observatory, and everything else is subordinate to it. Nothing has been provided which does not tend to make the work of the large equatorial more complete or more useful.

Professor E. S. Holden is the director of the observatory, and his staff of astronomers numbers Mr. S. W. Burnham, the greatest living observer of double stars; Mr. E. E. Barnard, the indefatigable discoverer of comets; Mr. J. M. Schaeberle, Mr. J. E. Keeler, and Mr. C. B. Hill.

* It hardly need be explained that the large photographs of the moon that are so well known are all greatly enlarged from the original negatives.

ON SOME STRANGE FEATS OF CALCULATING BOYS.

BY THE LATE R. A. PROCTOR.

(*Continued from page* 11.)

IT is easy, with practice, for any one of average powers to conceive of numbers pictured as dots in columns up to several hundreds, and to imagine such processes of change as I have described in a simple case. Of course this fact does not in one sense explain Colburn's feats with much larger numbers. For instance, I should have been as helpless to deal with the numbers Colburn attacked as any one who had never adopted the particular method of dealing with numbers described above. But there is this distinction between that method and the ordinary method. No conceivable amount of acquired skill in carrying out the ordinary arithmetical processes mentally could account for Colburn's feats; but the power required for the other method needs only to be possessed to an enhanced degree to enable the calculator to accomplish feats of the kind. It will be observed that when a number has been mentally pictured as a set of columns—so many units, tens, hundreds, thousands, and so on—the mind can proceed to picture this array of dots forming themselves into rank and file, so many wide and so many deep, with so many over when a complete rectangular phalanx is not formed. If in any such pictured arrangement there are none thus left over, then the number in each rank is one divisor, and that in each file is another. If the mental sergeant after conceiving the army set two deep, three deep, four deep, and so on, until rank is exceeded by file, finds no single case where there are *none* left over, then the number thus dealt with has no divisors. Again, if two equal multipliers are wanted to make up a number, or technically, if the square root of a number is wanted, the mind, after picturing the number, forms it into square—the equal number in rank and file being the required square root. Conversely, if a number is given to be multiplied by itself, the mind pictures a square army of dots with that number in rank and file, and then forms the army into columns of tens, hundreds, thousands, &c. Finding the cube roots depends on the same power of picturing a number of dots, only instead of picturing them as arranged on a flat surface like an army, they were probably conceived as set up within cube-shaped spaces. This would not be necessary in cubing numbers, or multiplying any number twice into itself; but in the reverse process it would be the readiest method. Still, quite possibly, the mental process actually followed by Colburn, when a number was given him whose cube root was required, may have simply corresponded to the rapid array of the army representing the number into a number of squares each having as many in rank and file as there were squares. Thus, suppose the number 64 (which to persons of average capacity for conceiving a number of points or dots would correspond to a large number submitted to Colburn), then the mind would successively picture this number as presented by two ranks of thirty-two and four ranks of sixteen, stopping at the last arrangement because

perceiving that these *four* ranks could be divided into *four* squares, each of *four*. The required cube root then is *four*.

But it may be argued that, admitting this explanation, the marvellous nature of Colburn's feat is in no way diminished. For, to minds of average power, the faculty of picturing the enormous arrays which the explanation requires is something altogether inconceivable. I am not concerned to make the feats of Colburn, Bidder, and others appear less marvellous than they are usually considered. They are unquestionably altogether amazing. But the point to which I would direct attention is that they involve marvellous developments of a faculty we all possess to *some* degree, and do not depend on hitherto undiscovered properties of numbers. It will be seen that, according to the explanation I have given, it is not some advanced and recondite property of numbers that is in question, but the mental development of the most elementary method of dealing with numbers—by actually picturing them. Apart from the mathematical grounds which exist for preferring this explanation to the other, it obviously seems more reasonable to infer that a faculty showing itself at an early stage of mental development (for every remarkable calculator has begun young, and most of them have entirely lost the faculty as they advanced towards manhood) must depend on the simplest principles of numbers, not on principles so abstruse as hitherto to have escaped detection even by the most advanced inquirers into numerical relations.

But the opinion the reader may form on such an explanation as I have here advanced will in part depend, no doubt, on the question whether independent evidence exists to show that the mind can form perfect pictures of a great number of objects, and conceive processes of change to take place, following these processes as confidently as though they took place under the eyes or were effected by the hands of the person conceiving them. It appears to me that there are few apter illustrations of this faculty than we find in the power which some chess-players possess of conducting several games simultaneously without seeing the board. It seems a sufficiently wonderful feat to play a single game without the board, and more wonderful perhaps to a good chess-player than to those little familiar with the game. We find, indeed, that for a long time after the game was invented the attempt was never made to play without boards. Glanvill, in his "Vanity of Dogmatising" (1661), talks of a "blind man managing a game at chess" much as one would speak of a blind man using a telescope—as a thing absurd on the face of it. He was a chess-player, too; and one would suppose he had at times thought over the games he had formerly played, and thus learned to some degree how a game can be mentally followed. But, as I have said, the feat of blindfold chess-playing is even more wonderful to a chess-player who does not possess the power of calling up before the mind a complete picture of board and men at any stage of a game, than it is to one unfamiliar with chess. For the player knows how varied the resources of the game commonly are at each stage, how the choice of any move from amongst several which are available depends on consequences calculated seven or eight moves deep (not for the selected move alone, but for each of the rejected moves). Now if the blindfold player reasoned out each move, by *considering* the scope and influence of each piece, arguing mentally, for instance, that such and such a piece having been moved to such and such a square commands such and such other squares, or can be brought in so many moves to some desired position, or must be guarded by such and such steps from other pieces, it would be simply impossible for him to conduct a game, or at least to complete one within any reasonable time. Yet, strangely enough, many chess-players suppose that it it is a feat of this kind which the blindfold player accomplishes. And necessarily the marvel, already great, becomes almost incredible when we recollect that three, ten, twelve, nay, if I remember rightly,* in one case twenty, blindfold games have been conducted simultaneously by one player.

The real meaning of the feat is understood, however, when we notice that some of the strongest chess-players have been unable to play blindfold, precisely as some of the greatest mathematicians have been unable to deal mentally with any but the very simplest problems. Philidor and La Bourdonnais could both play without seeing the board, but McDonnell, St. Amant, and Staunton never accomplished the feat (at least in any recorded *partie*). Harrwitz could play blindfold; his rival Horwitz could not. At the present day Blackburne and Zukertort can play ten or twelve games blindfold, but several of the strongest chess-players living do not, I believe, possess the power. We must, therefore, find an explanation which shall not require the blindfold player to be superior in chess-strength to the player who is unable to carry on a contest without seeing the board. The explanation is simple. The blindfold player is able to picture to himself the board and men, at any stage of a game, and thus plays mentally with as much ease and confidence as if he had the board before him. If he is conducting a dozen blindfold games simultaneously, his method is the same. I am unable to say, however, whether he pictures all the games at once as though the boards were ranged before him, or calls up a mental picture of each board with the men properly placed for that game as its turn comes round. Probably, in most cases, the latter is the method adopted. It matters little for my argument which manner of conceiving the boards and men † is preferred. In either case, we perceive that the mind must have a complete record of a great number of objects, and a power of conceiving changes of position amongst these objects, strictly analogous to that by which we have endeavoured to explain the feats of Zerah Colburn. When a blindfold chess-player (or rather a player without board, for the blindfolding is merely nominal) is conducting twelve games, he has, either in one mental image or available for successive study, twelve boards, each with 64 squares, or 768 squares to be separately recognised, with in all (at starting) 384 men. At every step he has to select between several alternative moves, each admitting of several alternative replies, each reply suggesting various lines of play, so that the total number of moves to be considered increases in geometrical proportion. To consider each position effectively, he must conceive the various steps of each line of play as actually taking place before him. To do this for ten or twelve games, against good players, surrounded by spectators who expect each game to progress without undue delay (so that he must play ten or twelve times as rapidly as his opponents) requires unquestionably a power of mental calculation rivalling in degree that shown in the feats of Colburn, Bidder, and others, though altogether different in kind. In fact it has been remarked by Todhunter, the mathematician, that skill in chess is a quality not unlike mathematics as a test of mental

* We believe Paulsen accomplished on one occasion the feat of playing twenty games simultaneously without seeing the board. We know certainly that Morphy, the stronger player of the two (and probably the strongest chess-player ever known), admitted that Paulsen could conduct more blindfold games simultaneously than himself, yet Morphy often played twelve blindfold games at once.

† In speaking of several games played simultaneously, I have no experience of my own to guide me. In my youth, I used often to play a single game without board, and I can still conduct a game in that way, though not so readily as of old, a break of nearly twenty years in chess practice having had the effect of diminishing the completeness of the mental image of board and men. It does not appear to me that I should find more difficulty in playing two or three games in this way than in playing one, though of course my play would be slower.

power, though with this important difference, that mathematics properly employed are useful in science, whereas the skill shown by the chess-player can afford no results corresponding to the labour acquired in attaining such skill. Of mere mathematical skill, apart from its useful application, Todhunter says well, that it is not so highly to be esteemed as the practice at Cambridge suggests. "It seems at least partially to resemble the chess-playing power which we find marvellously developed in some persons. The feats which we see or know to be performed by adepts at this game are very striking, but the utility of them may be doubted, whether we regard the chess-player as an end to himself or his country." This view of the resemblance between mathematical feats and feats of chess-playing has been—independently—enunciated also by Professor Atkinson, of Massachusetts Institute of Technology, who speaks of mathematical problems by themselves, and divorced from their connection with the physical sciences, as "hardly rising in dignity or educational value above the game of chess." *

(*To be continued.*)

THE JACKAL.

By Dr. ROBERT F. HUTCHINSON, Surgeon-General, Bengal Army. (Retired.)

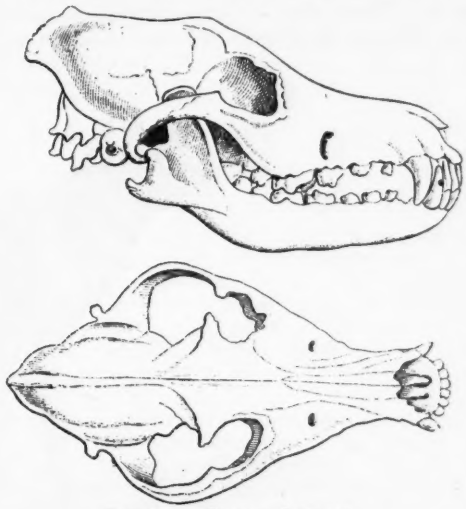
THIS animal, the shăkăl of the Persians and the gídăr of India, is very widely distributed throughout the three Indian Presidencies, but is less common in Burma. Wide though its range, and gregarious though its habits, it is comparatively rarely seen, though it is nightly heard in almost every station in India, including the Presidency towns. It is *the* great scavenger of India, rejoicing in offal of every description, and glad to carry off any young or maimed animal which is not properly protected. It also plays great havoc in gardens, being fond of melons and cucumbers and not despising grapes and sugar-cane.

In colour the jackal is of a dusky yellowish grey with a dash of rust over all; the height of the animal is about 16 inches, its length about 28 inches, without the short and shabby tail, which gives an additional 10 inches.

The jackal is strictly nocturnal in its habits, though it will not hesitate in stalking a wounded deer by daylight; all night long they are on the prowl, and when day breaks they prepare for rest wherever it finds them. Often have I come across a sleeping jackal in a field or ditch, and, touching him up with my stick, have been amused at his attempts at counterfeiting death. Pretending to recognise him as dead, I have quietly retreated with one eye on my friend, have noted him steadily watching my every movement, though appearing to be limp and dejected, and then suddenly rising and scuttling off as fast as he could.

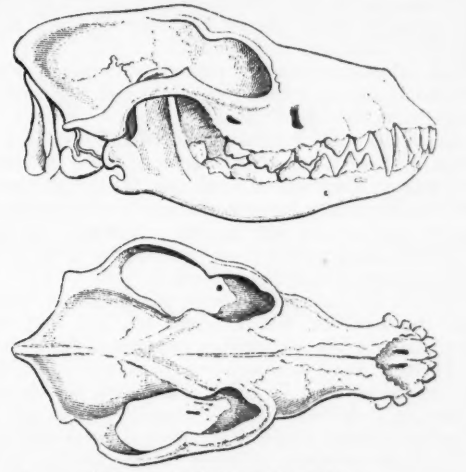
All military stations keep packs of dogs for hunting jackals or a stray wolf.

Stories are on record that during these hunts kindred



SKULLS OF INDIAN JACKALS.

jackals have flocked to the assistance of their hunted brother, and have severely assailed the pack. The Rev. J. C. Wood narrates a case in point: "On one of these occasions two greyhounds had been sent in pursuit of a jackal, who immediately made for rising ground, covered with grass and small bushes. The dogs and I arrived at the



SKULLS OF INDIAN JACKALS.

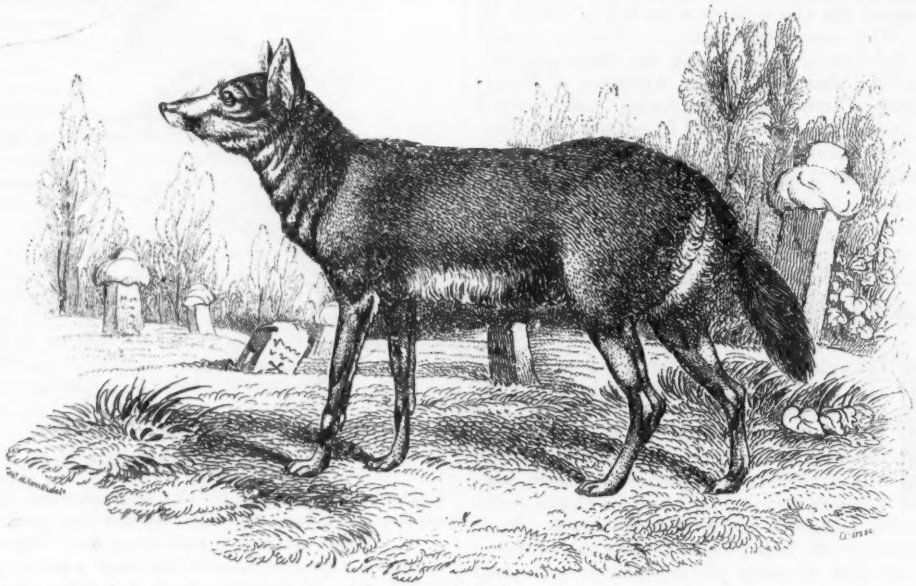
spot almost simultaneously, when the jackal gave a cry of distress, which was immediately answered by the appearance of a small pack of jackals, which issued in every direction from the cover and attacked the dogs. Their owner was at the time impounded in thick mud, and could not reach the spot in time to rescue his hounds from their furious enemies until they had been most severely mauled."

To return to the jackal as a scavenger. Lying all day in

* It is rather singular that a chess-player of note, Herr Kling, has given to a treatise on the game the title "Chess-Euclid." Ernest Morphy, uncle of Paul Morphy, has written a work entitled the "Logic of Chess." We find in a sketch of P. Morphy's doings in Europe, in 1858, a passage at once indicating his natural aptitude for the game and its quasi-mathematical character. "In answer to a gentleman in Paris as to whether he had not studied many works on che s, I heard him state," says the writer of the sketch, "that no author had been of much value to him, and that he was astonished at finding various positions and solutions given as novel—certain moves producing certain results, &c.," *for that he had made the same deductions himself as necessary consequences.* In like manner, Newton demonstrated in his own mind the problems of Euclid, the enunciations only being given, "and I can think of no more suitable epithet for Morphy than to call him the 'Newton of Chess.'" The last sentence, however, is absurd. I may add that it was not Newton, but, if I remember rightly, Thos. Chalmers, who is said to have supplied the demonstrations of Euclid's propositions when the enunciations only had been given him (Newton said that the propositions appeared to him self-evident). Several well-known mathematicians have been skilful chess-players; and Anderssen, who was victor in the chess tourneys of 1851 and 1862, is Professor of Mathematics in the University of Breslau.

a drain or ditch or convenient hole, he wakes up as darkness falls on the scene and utters the masonic cry which brings up to him all neighbouring brethren, and then they arrange their plans for the night and sally forth at the canter. To the novice in India it is a startling thing to hear the cry and the rush of the many feet of those joining in the chorus.

Solo. Here's-s-s-s the body of an old Hindu-u-u-u-u.
Chorus. Where, where? Where, where?
Solo. Here, here! Here, here!



The Jackal.

In India during the hot weather we are very fond of sleeping in the open, and oft have my slumbers been interrupted by the yells of the jackal.

These animals are prone to rabies, and numerous cases of hydrophobia among sleepers-out, native and European, have occurred from the bite of rabid jackals.

Jackals are difficult to domesticate, and I do not think one has ever been thoroughly tamed or cured of the habit of snapping. Dogs will not tolerate them, and, therefore, their coexistence in a house is impossible, their bodies being offensive and covered with vermin. Moreover, the change of diet and habit rapidly proves fatal to the jackal, if it has not already reverted to its wild state.

We find the jackal frequently mentioned in the Bible under the term fox, and I doubt not but that Samson utilised them in his onslaught on the crops of the Philistines; the Hebrew word is shuál which closely resembles the Bengali names shiál or shiálu; moreover, jackals are gregarious in their habits while foxes are not, and, being feeders on carrion, which foxes are not, could with ease be entrapped in numbers by being enticed, say into a walled enclosure with but one entrance, and that trapped to prevent exit. It does not follow that Samson's "300 foxes" were caught in one spot, though such a feat would not be actually impossible in a jackal-infested district, which means one properly inhabited, jackals rarely, if ever, being found in actual deserts. We know that Palestine was densely populous, and, therefore, had any amount of jackal centres. Each village, as in India, had its "place of skull," and thither, at night, would jackals congregate.

Mr. Elliot mentions the belief in the south of India, that an old jackal attends the tiger and notes his proximity by a peculiar cry. This attendant is called the Bhálū. In Bengal this attendant is called Pheáll, and several sportsmen have testified to his existence. Thus Johnson in his "Field Sports of India" remarks:—"Soon after the tiger passed within a few yards of us. In a minute or two after he had passed we plainly saw the jackal and heard him cry when very near us. I have often heard it said that the Pheáll always goes before the tiger, but in this instance he followed him, which I have also seen him do at other times. Whether he is induced to follow the tiger for the sake of coming in for a part of the booty, or whether he merely follows as small birds often follow a bird of prey, I cannot say. Evidently his cry is different from what it is at other times, which indicates danger being near, particularly as whenever that cry is heard, the voice of no other jackal is, nor is that peculiar call ever heard in any part of the country where there are not large beasts of prey."

Apropos to the value of the jackal as a scavenger, every village has its Golgotha whither the carcases of dead cattle are dragged; thither by day flock vultures and carrion crows, and thither by night crowd the jackals and any stray hyæna which may be in the neighbourhood. Day and night, as long as the feast lasts, are rendered equally hideous by the squabbling of the winged and the snarling of the four-footed scavengers.

Thus it will be seen that the jackal is a useful, if not ornamental member of society.

NOTES.

Mr. W. Crookes, F.R.S., has presented to the Department of Science and Art a collection of sixty-eight radiometers and similar instruments for permanent exhibition in the science galleries of the South Kensington Museum. They illustrate the steps by which Mr. Crookes was led to the construction of the radiometer, and to the production of motion and of phosphorescence by streams of electrified molecules in high vacua. Many of the instruments are of

the greatest historical interest. Among them is included the first radiometer, with many others which are described in Mr. Crookes's papers in the Philosophical Transactions of the Royal Society. Others are of considerable value, as they contain collections of diamonds, rubies, &c., for the exhibition of the phenomena of phosphorescence. Nearly all are in working order, and will be of great use in illustrating lectures to students. The collection will be on view in the galleries of the museum in Queen's Gate as soon as the necessary stands and fittings are completed.

OCEAN TEMPERATURE.

In a paper read before the Society of Telegraph Engineers and Electricians on November 8, and entitled "On Ocean Temperature in relation to Submarine Cables," the author (W. Lant Carpenter) mentioned the fact that the temperature of the Mediterranean was found to be 54° F. at a depth of 2,000 fathoms (2¼ miles nearly), while in the Atlantic, at no great distance, at the same depth 36° was the temperature met with. Other instances of the difference between the thermal conditions of partially land-locked seas and the ocean were given, among them the Red Sea, in which 71° F. is the minimum temperature; and in the case of the Sulu Sea, on the line of the cable between Singapore and Hong Kong the lowest temperature was found to be 50°·5 at a depth of 2,550 fathoms; while at the same depth in the Indian Ocean and Celebes Sea, the temperature was between 32° and 33°.—*Electrical Review.*

The Transactions of the County of Middlesex Natural History and Science Society, of which Professor W. H. Flower is President, and Mr. Mattieu Williams, secretary, contains a number of interesting papers, amongst others a lecture on "Horns and Antlers," by Professor Flower; a paper "On the Water-Supply of Middlesex and the Metropolis," "On the Chemistry of the London Clay," by Mr. Mattieu Williams. The Society admits ladies to membership, and geological, botanical, and other expeditions are organised by the more active members.

The average daily consumption of water in the metropolis during the last seven years has been 31·32 gallons per head. The maximum was 34·53 gallons and the minimum 28·12. The supply is greatest during the months of July and August, and least during the winter months.—*Engineering.*

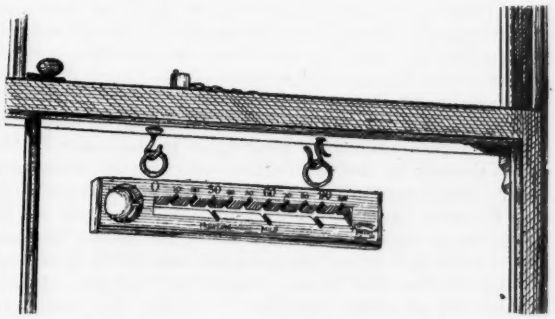
Two large gold nuggets have recently been discovered in the Roeburne district of Western Australia. The larger one weighed 160 oz., and the smaller 103 oz. An unusual feature about the latter is the fact that it was discovered lying on the surface, and it was at first actually kicked away by the finder, in ignorance of its real value. At Bendigo, in the colony of Victoria, gold is now being procured at the depth of 2,400 feet from the surface, this being the greatest depth yet reached by the Antipodean gold-seekers.—*Iron.*

NEW FORM OF COMPENSATING PENDULUM.

At the last meeting of the Astronomical Society Mr. R. Inwards read a paper on a new form of compensating pendulum which he has devised. The pendulum is reduced to its simplest form—namely, a steel sphere supported by a steel rod, adjustable in length by a screw nut. The pendulum is suspended from a solid iron support by a steel spring, which is clasped between jaws which move up and down with all changes of temperature, and so alter the centre of oscillation in a manner which corresponds to the increase or decrease of the length of the steel pendulum. The jaws clasping the spring are attached to a slide which moves smoothly up and down in the solid iron support at the back of the pendulum, being lowered by heat and raised by cold in a manner exactly contrary to the changes of length produced by temperature in the steel pendulum. The slide is pushed up or down by the extension or contraction of a zinc column, the length of which can be regulated by a screw motion with great nicety. A somewhat similar idea seems to have occurred previously to Lord Grimthorpe (the inventor of the Gravity escapement) but was rejected by him owing to the difficulty in obtaining a smooth motion of the sliding jaws which clasp the suspension spring. Mr. Inwards states that this difficulty has now been satisfactorily overcome.

MITCHELL'S MINIMUM THERMOMETER.

This thermometer is intended to be hung outside a window, so that its scale can be set by a person indoors without opening the window. It is placed so that it can be seen against the sky, and the height of the column of mercury or spirit is read by transmitted light, and not by reflected light, as in the case of thermometers hung against a wall. This greatly increases the ease with which the instrument may be read, and both sides of the bulb and tube are exposed to the air, so that they rapidly take up the temperature of the air, and the instrument is not so much affected by the heat of the wall or support on which it is hung. The tube is protected from injury by being sunk in a slit which is cut through the thermometer frame, or the block of wood to which the tube is fastened. The sides of the slit are notched at convenient intervals corresponding with the engraved scale which shows the height of the column. When the thermometer is hung so as to be seen on the background of the sky, these notches appear like stars or



beads of light adjacent to the tube of the thermometer, and enable the height of the column of mercury or coloured spirit to be read from a considerable distance—for instance, by a person in bed in the morning without getting up.

The thermometer is intended to be hung outside the glass of the window from the underside of the sash, as shown in the diagram. The hook at the bulb end is fixed in the woodwork; but the hook at the other end is attached to a chain which passes through a moderate-sized gimblet hole in the woodwork, and lies along the top of the sash inside the room. A person wishing to set the thermometer unhooks a ring at the end of the chain, which passes over a brass pin that stands up from the top of the sash, and lets down the left-hand end of the thermometer, so that the bulb is highest. The setter (which, as in the ordinary minimum thermometer, is a little pin of black glass within the tube) is made loose, and slips down by the action of gravity until it reaches the end of the column of fluid, where its further progress is checked by the surface tension of the fluid. The thermometer is then drawn up again,

and the setter is left in position, so that it will be drawn backwards by the receding column of fluid, and again mark the minimum temperature registered.

NEW EXPLOSIVE.

Bellite is the name of a new explosive discovered by Mr. Carl Lamm. It consists of five parts nitrate of ammonia to one part of bi-nitro-benzine, and while 30 per cent. more powerful than dynamite, possesses the advantage of being absolutely safe during manufacture, transportation, or when used in fire-damp mines. It is also perfectly flameless, and gives off no offensive gases when exploded—which can only be effected by a strong detonating cap—it is indifferent to shock, pressure, friction, fire, lightning or electricity, none of these agencies being able to cause explosion. It is unaffected by extreme frost or tropical heat, but resembles most other explosives in being affected by atmospheric moisture or damp. In every other respect it seems to approach nearer than any other preparation to what the ideal explosive for mining purposes should be.

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

To the Editor of KNOWLEDGE.

SIR,—The following instance of intelligence in a cat in my possession may be of interest to the readers of KNOWLEDGE. The animal in question is a black and white female, aged about seven months. It follows one about like a dog, and is of a remarkably stay-at-home disposition, never caring to roam about out of doors, either day or night, as most cats do; whenever it does go into the garden it always returns indoors in a few minutes, and if not let in, after mewing once or twice, it immediately proceeds to admit itself—an accomplishment it taught itself about a month ago. To do this it has to jump up to the latch, a height of 4 feet 5 inches, and, while hanging on to the handle by the aid of three of its feet, it lifts the latch with its disengaged paw. Before succeeding in gaining admittance it generally has to make three or four unsuccessful attempts, but let herself in pussy will. It is the fact of its having to jump at the latch that makes me think the case worth recording; there is no other cat to have taught her the trick, nor any window-sill or other projection on which puss can stand while reaching the latch, as was the case in one other instance of a cat doing the same thing that came under my notice some years ago.

Forest Gate, E., Nov. 20. B. J. HOPKINS.

To the Editor of KNOWLEDGE.

SIR,—In your last number Mr. Ranyard quotes the opinion of several men of note who wrote before Mr. Auberon Herbert's day to show that the system of competitive examination has, to put it mildly, its drawbacks. But the only suggestion given is that we might possibly do a little better if we adopted the method of the Middle Ages, and went back to moots.

If it is necessary to select Government employés by examination of some kind, pray deliver us from a class of officials who have been selected for their skill in talking. We are already far too much governed by talkers, "knights of the plausible tongue." For my part, I would far rather have to deal with officials who had been selected for their good memories, or because they were over six feet high, than with a class who had gained their official positions by success in debate, even though the debate had been presided over by a professor, which, I conclude, is all a moot amounts to.—Yours faithfully, ANTI-TALKER.

[The suggestion with regard to moots was thrown out by Professor Baden Powell. But it does not appear that it was adopted by De Morgan, Whewell, or Sir John Herschel, the only other writers mentioned. Mr. Ranyard's suggestion was, that selecting officers should have an opportunity of watching candidates while attempting the class of work at which they would afterwards be employed.—EDITOR.]

HOW COMETS COME TO US.

COMET E (1888), discovered by Mr. Barnard at the Lick Observatory, on September 2, is now just visible to the naked eye, and is easily seen with an opera-glass. It is especially interesting, as it appears to belong to the rare class of comets which move in hyperbolic orbits. Usually the observed path is satisfied by a parabolic orbit—that is, the comet is probably moving either in a long ellipse, which is undistinguishable from a parabola, or in a hyperbolic orbit in which the velocity is so little above the velocity which would be attained by falling towards the sun from an infinite distance that the form of the orbit cannot be distinguished from a parabola.

In the case of Comet *e* (1888) there seems to be evidence that it is moving in a path which shows that it must have been projected from a distant part of space towards our system—and that, after passing round the sun, it will travel from us, never to return again. Or, to speak more strictly, it cannot return until it has passed round more than one star or other attracting centre. But the velocity with which these comets move is so little above the velocity which they would acquire by the action of gravity in falling towards the sun (all of which velocity will be lost again as they move away on the receding branch of the hyperbola) that the time which they must occupy in traversing the interstellar spaces is altogether inconceivable by the human mind.

Thus a comet would occupy a little more than eight million three hundred and twenty-seven thousand years in falling freely to the sun from a point halfway between us and a star with a parallax of half a second of arc, and there are very few stars which show a greater parallax than half a second.

If we suppose the star from which the comet is coming to have a mass equal to the mass of our sun, and that the comet was projected directly towards us, its upward flight from the star to the point midway between the star and our sun (206265 radii of the earth's orbit away from us) would, neglecting our sun's attraction, occupy another eight million years, and the whole journey from star to sun would occupy more than sixteen and a half million years.

More than twenty years ago Dr. Hoek of Utrecht showed that there were many points in the heavens round which the aphelia of comets group themselves in a remarkable manner, as if these points were centres from which comets emanated. Some of these points correspond with the position of large stars, while others are marked by no conspicuous star.

There is frequently considerable difficulty in determining the orbit of a comet with great accuracy, owing sometimes to the nebulous character of the body whose position has to be measured, and sometimes to the fact that the position and form of the nucleus changes within its nebulous envelope as the comet comes to perihelion. But considering the amount of accuracy with which cometary orbits can in general be determined, the grouping of the aphelia of

their orbits pointed out by Dr. Hoek is a very remarkable phenomenon, which we may safely conclude corresponds to some great physical fact, the chances being many millions to one against such groups occurring if cometary orbits were distributed at random over the celestial sphere.

Dr. Hoek showed that comets which reach the neighbourhood of the sun after intervals of several years may be connected, and that they probably left the star or centre of emanation in space from which they started at the same time, with velocities only slightly differing from one another. Thus, for example, the three Comets 1860 III., Comet 1863 I., and Comet 1863 VI., form a system. For at a great distance from the sun (as they approached the solar system) they were moving together in a direction nearly corresponding with the line which joins our sun with the star γ Hydri.

Though they were separated by considerable intervals when they arrived in the sun's neighbourhood, and their orbits were not otherwise identical, one finds that they were nearer and nearer together the further we go backwards along their orbits. Thus, at the end of 1857, or more exactly at the epoch 1857·98, Comet 1860 III. was at a distance of 10 radii of the terrestrial orbit from the sun, while Comet 1863 I. was at a distance of 15·92 radii of the terrestrial orbit (which for simplicity we will call *units*) from the sun, and Comet 1863 VI. was at a distance of 17·39 units. They were then all three in the same part of the heavens; that is, they fell within a circle with a radius of 6°, though of course they were at that time none of them visible.

At the beginning of August 1833, Comet 1860 III. was at a distance of 50 units from the sun, Comet 1863 I. was at a distance of 52·76 units, and Comet 1863 VI. was at a distance of 53·35 units, and they were nearer together upon the sky.

At the beginning of February 1785, Comet 1860 III. was at a distance of 100 units from the sun, while Comet 1863 I. was at a distance of 101·83 units, and Comet 1863 VI. was at a distance of 102·11 units.

At the beginning of January 1470, Comet 1860 III. was at a distance of 300 units from the sun, while Comet 1863 I. was at a distance of 300·86 units, and Comet 1863 VI. was at a distance of 300·80 units.

At the end of December A.D. 756, Comet 1860 III. was at a distance of 600 units from the sun, while Comet 1863 I. was at a distance of 600·42 units, and Comet 1863 VI. was at a distance of 600·25 units. A. C. RANYARD.

DUN ECHT CIRCULAR.—No. 164.

November 12.

Dr. Ludwig Becker has calculated elements of Barnard's Comet of September 2 by the method of Variation of the Distances. The most probable orbit thus obtained is hyperbolic in character and, as will be seen by the residuals, represents the observations much better than the most probable parabola.

		Residuals: Hyperbola		Parabola	
		$\Delta\lambda\cos\beta$	$\Delta\beta$	$\Delta\lambda\cos\beta$	$\Delta\beta$
Sept. 2	Mt. Hamilton	0″·0	0″·0	0″·0	0″·0
12	Mt. Hamilton, Madison ...	−1·4	+7·5	−6·6	+11·6
21	Berlin	+3·5	+0·4	−3·8	+ 7·1
Oct. 1	Berlin, Rome, Dresden, Hamburg	+0·4	+1·4	−3·4	+12·5
8	Kiel	−2·9	−1·9	−2·7	+10·9
28	Dun Echt (Meridian Obs.)	+0·1	+0·3	−1·6	+ 2·1
29	„ „	0·0	0·0	0·0	0·0

Elements.

T = 1889, January, 29·90453 Greenwich M. T.

π $\Omega = 339°\ 54'\ 32''{\cdot}1$
$\Omega = 357\ \ 15\ \ 59\ {\cdot}1$ Mean Equinox 1888·0
$i = 166\ \ 22\ \ 24\ {\cdot}3$

$\log q = 0{\cdot}2595204$
$\log e = 0{\cdot}0135800$

Ephemeris for Greenwich Midnight.

1888		R.A. h	m	s	Decl. °	′	log Δ	log r	I
Nov.	13	4	17	20	−1	8·1	0·0527	0·3162	11·0
	14	4	10	49	1	28·8			
	15	4	4	11	1	49·6			
	16	3	57	27	2	10·3			
	17	3	50	37	2	30·8	0·0405	0·3112	11·8
	18	3	43	43	2	51·0			
	19	3	36	46	3	10·9			
	20	3	29	46	3	30·4			
	21	3	22	45	3	49·4	0·0359	0·3063	12·4
	22	3	15	44	4	7·8			
	23	3	8	44	4	25·6			
	24	3	1	46	4	42·8			
	25	2	54	51	4	59·4	0·0393	0·3016	12·5
	26	2	48	0	5	15·2			
	27	2	41	14	5	30·1			
	28	2	34	34	5	44·1			
	29	2	28	2	5	57·3	0·0501	0·2971	12·1
	30	2	21	36	6	9·6			
Dec.	1	2	15	18	6	21·0			
	2	2	9	9	6	31·6			
	3	2	3	9	6	41·4	0·0669	0·2928	11·4
	4	1	57	19	6	50·3			
	5	1	51	40	6	58·4			
	6	1	46	10	7	5·7			
	7	1	40	50	7	12·2	0·0887	0·2887	10·5
	8	1	35	41	7	18·1			
	9	1	30	42	7	23·2			
	10	1	25	53	7	27·7			
	11	1	21	15	7	31·5	0·1131	0·2847	9·6
	12	1	16	47	7	34·8			
	13	1	12	29	7	37·5			
	14	1	8	20	7	39·6			
	15	1	4	21	7	41·2	0·1390	0·2810	8·7
	16	1	0	32	7	42·4			
	17	0	56	52	7	43·1			
	18	0	53	21	7	43·4			
	19	0	49	59	7	43·4	0·1654	0·2776	7·8
	20	0	46	45	7	43·1			
	21	0	43	38	7	42·4			
	22	0	40	39	7	41·4			
	23	0	37	47	7	40·1	0·1916	0·2744	7·0
	24	0	35	2	7	38·6			
	25	0	32	24	7	36·9			
	26	0	29	53	7	35·0			
	27	0	27	29	7	32·8	0·2170	0·2715	6·3
	28	0	25	10	7	30·4			
	29	0	22	57	7	27·8			
	30	0	20	50	7	25·0			
	31	0	18	49	7	22·1	0·2414	0·2687	5·7
1889									
Jan.	1	0	16	52	7	19·0			
	2	0	15	1	7	15·8			
	3	0	13	15	7	12·5			
	4	0	11	33	7	9·1	0·2645	0·2665	5·2
	5	0	9	55	7	5·6			
	6	0	8	21	7	1·9			
	7	0	6	51	6	58·1			
	8	0	5	25	6	54·3	0·2863	0·2644	4·7
	9	0	4	2	6	50·4			
	10	0	2	43	6	46·4			
	11	0	1	27	6	42·5			
	12	0	0	15	6	38·5	0·3066	0·2625	4·4

The brightness, I, on September 2, has been taken as unity.

RALPH COPELAND.

Lord Crawford's Observatory, Dun Echt.

THE UNKNOWN HORN OF AFRICA.*

UNDER the foregoing title the author of this agreeably written record of a sorely-hindered expedition designates the great eastern promontory which lies, roughly speaking, between Abyssinia and Zanzibar. Casting a glance at the map of Africa, the first feeling is one of surprise that a country which is faced by our own important possession, Aden, and part of

* By F. L. James, M.A., F.R.G.S., author of "Wild Tribes of the Soudan." London: George Philip & Sons.

the littoral of which is now British territory, should have remained so long a sealed book to Europeans. The explanation seems to lie in the hostile and treacherous disposition of the Somali tribes—marauding, semi-civilised

Somali Men and Woman.

half-castes, offshoots of the great Galla race, allied to the Caucasian type by a steady influx of pure Asiatic blood. They are Mohammedans, but the rites of their religion, as might be expected, sit somewhat loosely upon them. Although their trust is in Allah, they have been known to ask where he can be found, "as some of them would like to catch him and spear him on the spot for having laid waste their homes and killed their wives and cattle." Mr. James says that sudden prayers are let off with great fervour during moments of anxiety, in the possibility of their affording some relief to feelings in a state of tension. In contradistinction to the prevailing custom in civilised communities, public prayer is almost confined to the male part of the population. This is not because the women are in any way prohibited from taking part in such ceremonies, but merely because they rarely seem to have any inclination to do so, and it is no uncommon thing to hear them say that they much prefer to let their husbands pray for them.

The story of early attempts to penetrate Somali-land appears to be uniformly one of disaster, so that, as Mr. Ravenstein has said, "to be killed was the fate of nearly every white man who ventured into the country." To Mr. James and his brother, with their travelling companions, belongs the credit of having explored the country from Berbera to the banks of the Webbe Shebeyli, 5° 25′ N. latitude, a distance of three hundred and fifty miles, the journey occupying just two months. We have an interesting and graphic description of the preparations for the expedition through an always inhospitable and often barren land. The hire of camels and their drivers was ratified by contract, and by the swearing of the usual Somali oath that if the man failed to keep the terms of the contract he would *divorce his wife*. "All this was very imposing," the author tells us, "but the penalty of divorcing the wife in the event of breaking the contract did not seem to represent any strong security. None of us would probably see our way to utilising the divorced wife as a *quid pro quo* for the defalcation of her mate!" Mr. James had to engage some "lady-helps," as the men refused to build their own mat-huts or do any cooking. None of their fathers had done this, so they argued, and were they to do the work of women the tribes through which they passed would despise them. The domestic difficulty has, however, not reached Somali-land, and from the candidates presenting themselves five widows or divorced wives were chosen, and one unmarried girl, who hoped that she would find a suitable husband during the march. In this we regret to learn that Hubla, for such was the tawny one's name, was disappointed. The experiment proved a success, for the women gave themselves no airs, and nature had denied them graces. The party was pestered from start to finish by demands for tribute from the tribes through whose districts it passed; but far more serious annoyance, threatening even disaster, was caused by the injudiciousness of Major Hunter, the consul of the Somali coast. When the travellers had got well on their journey they were overtaken by messengers bringing telegrams, informing them that the consul had received instructions, first to dissuade Mr. James from undertaking the expedition, and next to stop him by force if it was persisted in. This action of the home authorities was due to the consul's report that he considered the expedition "most dangerous;" and its effect was aggravated by his folly in letting the contents of the telegrams be made public. Mr. James, however, wisely resolved to push on. The country through which the caravan passed has little of variety or charm, and large tracts of it are compared to "a kitchen garden, where only dead gooseberry and currant bushes are found." That stock privation of African travel, scarcity of water, aggravated by the mocking mirage, was often felt; neither did digging and scraping for the precious fluid yield much result. It was bad enough for the men, but worse for the baggage-camels, which on one occasion travelled for thirteen days without drinking a drop of water.

On the whole, the journey must be pronounced monotonous. Some excitement was caused when the caravan

Portrait of Hubla in Parisian Head-gear.

reached Gerloguby, where the people believed it had descended from the heavens. Any lurking scepticism as to its celestial origin was removed when Mr. James and the others began to smoke. "The pipe was part of ourselves, for how else could our mouths blow forth clouds, which would of course bring down rain?" As succeeding curls of

smoke ascended, succeeding groups of natives approached and followed with straining eyes the mystery of tobacco melting into space. We explained that these clouds were not "water-bearers," but only due to plants lighted by harmless firemakers, and to prove this one of us struck a match and lit up a fresh cigarette. Further bewilderment succeeded an illustration which I hoped would have insured applause. The match had produced lightning, and of course the clouds could produce thunder, so we were "storm-makers." As the party included a doctor, applicants for

BUCK-JUMPING MULE.

advice gratis were somewhat numerous. "Rheumatism and itch were endemic, and the run on sulphur was terrific." Some interesting but incurable cases of smashed bones were submitted, with which the doctor declined to grapple. An interview with one of the priests, to whom Mr. James wisely gave a Koran, a supply of which he found invaluable, was followed by a visit from a man reported to be one hundred years old, and to have killed two hundred men, on which account he dared not show himself in Berbera. "Two men a year is not a bad average fall from the sword of a Somali warrior, but it was of course a mere bagatelle to the fall from the lancet of any fashionable English doctor in olden days. I did venture to say this to our visitor, but my brother told him that the white doctor belonged to a tribe whose killing history was great and fearful even as his." Altogether, we shut the book with pleasant impressions of the relations of the travellers with the natives, which cannot fail to yield good fruit.

The result of the expedition goes to show that Somali-land offers no temptations to the enterprise of the bagman; it has little or nothing to export, and imports would probably be artificial additions to the few needs of the people. To have learned thus much is a gain which places the civilised world under obligation to Mr. James, and that obligation is increased by the important additions which he has made to our knowledge of the plants and animals—among these a remarkable rodent about the size of a mouse—of Somali-land. Excellent plates, with descriptive appendices by well-known experts, illustrate this part of the work, while the skill of Mrs. Gordon Hake has worked up spirited pictures of the Somali from photographs taken on the spot by Messrs. W. D. James and Percy Aylmer, who also contribute a clear and careful map of the country. EDW. CLODD.

SIR WILLIAM SIEMENS.*

JUST five years ago the subject of this deeply interesting memoir passed from among us, almost suddenly, cut off by an apparently trifling accident in the midst of his work—a worker of whom it was well said at the time, that "looking back along the long line of England's scientific worthies, there were few who had served the people better than this, her adopted son, and perhaps none who had done more to better the lives of their fellow-men, by teaching them how to adapt the energies of nature to their use." The long period that has elapsed since Sir William Siemens's death, and the distinguished character of his biographer, led to the indulgence of great expectations on the part of the public as to the excellence of the book. Now that it has at last been published, we may say that such reasonable expectations are fulfilled in the volume before us, and we congratulate Dr. Pole upon the successful issue of his labour of love. The book will probably have three distinct classes of readers, each differently interested in its contents. The large circle of the private friends may expect to find in it the history of all the varied events of his chequered life; another large group of experts may look more specially for records of his engineering and scientific labours; while the general public may only desire to learn what manner of man he was, and how he came to gain such honour and popularity. In endeavouring to provide for all these varied requirements, our author has been very successful; the book is eminently readable, and we venture to think that the lesson of Sir W. Siemens's life, as there told, will be very useful to young men.

Carl Wilhelm Siemens was the seventh child of Ferdinand and Eleonore Siemens, and was the fourth of the sons who lived to adult age. He was born at Lenthe on April 4, 1823. At a very early age, he manifested a most careful and attentive observation of men and things, as well as self-reliance and independence of character; but in no other way was the child the father of the man who became one of the best mechanics in the most mechanical country in the world, and about whom it was commonly said in his workshops that as soon as a particular problem had been given up by everybody else, it had only to be taken to Mr. William Siemens for him to suggest half-a-dozen ways of solving it, two of which would be complicated and impracticable, two difficult, and two perfectly satisfactory. It was due to the acute penetration of his elder brother, Werner, then a student in the Artillery School, that the mercantile career proposed for William was abandoned in favour of a mechanical one. The picture drawn by the biographer of the fostering care with which, often at the expense of great self-denial, the elder brother watched over and assisted the early part of the career of the younger, is very touching. In March 1843, William Siemens came to England to dispose of an improved process for electro-plating, which had been worked out by some members of the family, and he succeeded in getting Messrs. Elkington to take it up, with great pecuniary advantage to himself and his family, and this firm always remained his powerful friends and supporters. On his second visit to England in 1844, he received so much encouragement from leading engineers and scientific men as to lead him to believe that a more congenial and profitable field for his labour would be found there than in his native country; from that time England became his home.

To give, even in briefest outline, a notice of even the

* "The Life of Sir William Siemens, F.R.S., D.C.L., LL.D." By William Pole, F.R.S., Hon. Secretary of the Institution of Civil Engineers. (London: John Murray.)

more important results of Sir William Siemens's work in England would extend the limits of this notice far beyond the allotted space. Heat and electricity were the two manifestations of energy in nature with which he was most immediately concerned, and it is hard to say in which region the more valuable results were obtained. During his first years in England he devoted much time to working out his "regenerative" steam-engine in the factories of Messrs. Hicks & Hargreaves, at Bolton, and Messrs. Fox & Henderson. The history of his perseverance in this matter, in the face of great discouragement and difficulties, is most instructive. Although the engine itself did not achieve a decided success, the principle involved, viz., the "regeneration" of heat, was subsequently applied very extensively in the construction of the regenerative furnaces, for any chemical or metallurgical operation requiring high temperature on a large scale, an enormous saving in fuel being the result. After nearly twenty years of continuous working and application, Sir Henry Bessemer, one of the first authorities on the subject, described the furnace as at once the most philosophic in principle, the most powerful in action, and the most economical of all the contrivances for producing heat by the combustion of fuel. The memoir brings out well the numerous different directions in which his active mind was working simultaneously. At the same time that he was investigating heat he was engaged in constructing and perfecting his water-meter (a very great commercial success), his chronometric governor, the process of "anastatic" printing, and, not content with these, he was appointed agent in England to the newly established firm of Siemens & Halske, in Berlin, where large quantities of electrical and telegraphic apparatus were constructed. In 1858 a branch of the firm opened a factory in Westminster under his immediate supervision, and having determined to naturalise himself in this country, on March 19, 1859, as he used amusingly to say, he took oath and allegiance to two ladies in one day, the Queen, and his chosen partner in life, Miss Anne Gordon. Shortly after this, he brought out his process for the manufacture of steel with the aid of his regenerative furnace, dividing his attention between this and his electrical work; in 1864, he started and organised at Charlton, Woolwich, the famous telegraph works with which his name is so closely associated. They now occupy an area of six acres, and have been capable of turning out sixty miles of submarine cable per day. For a very graphic account of the construction and installation of the Indo-European telegraph, of the cable ship *Faraday*, of several Atlantic and other submarine cables, as well as of the varied applications of the dynamo machine to electric lighting, to the transmission of power, &c., we must refer our readers to the volume itself.

Notwithstanding the very numerous claims upon his time and attention, Dr. Siemens was always ready to advance the interests of the numerous scientific societies with which he was associated, by reading papers, contributing to their discussions, and guiding their management with his clear and vigorous judgment. He had great sympathy with young men at their entrance into life, and would frequently put himself to considerable inconvenience to serve them. In the later years of his life he was able to devote a larger portion of his time to purely scientific pursuits, and the records of several learned societies bear testimony to his activity in this direction, and in some instances to the daring originality of his conceptions. After he had passed away, on November 19, 1883, it was well said of him: "A noble, beautiful, and gifted spirit has passed to the higher and fuller life, and with us is left an influence for good which cannot die. Just as this generation is now profiting by the solar radiation which fell on the earth countless ages ago, so will the labours of Charles William Siemens form a store of knowledge potential with respect to his and succeeding generations, and destined to confer advantages greater than we can now estimate on the ever-advancing cause of science, and on the moral, intellectual, and material progress of humanity."

Wm. Lant Carpenter.

Reviews.

Truth for its Own Sake. The Story of Charles Darwin by W. Mawer, F.G.S. (London: Swan Sonnenschein & Co.), is an unpretentious and pleasing little book, intended as a gift for young people. It contains many stories with respect to Darwin's life and work likely to strike the imagination of a boy, and older people too. The facts, as one would naturally suppose, are chiefly derived from "The Voyage of the *Beagle*" and the "Life and Letters of Charles Darwin" (in 3 vols.) by his son, Francis Darwin. But the book contains some additional matter, and will be welcomed by those who have not found time to read the larger volumes. Dr. Darwin used to say that his real training began with his voyage in the *Beagle*, where he had "just room enough to turn round, and that was all." The necessity for tidiness in the little space at his disposal helped "to give him methodical habits of working." His powers of observation were then exercised to the fullest degree, and the writing of his journal was a great means of education to him.

Probably no man who has been held up as an example to the world has displayed greater care in making statements than Charles Darwin. His patient pursuit of truth is contrasted with the loose methods of narration so often adopted by people who would on no account knowingly tell a falsehood, and the value of a diligent search after truth as a method of training is dwelt upon in an interesting manner. The book has for frontispiece an excellent picture of Dr. Darwin sitting in a chair from a photograph taken by his son, Captain L. Darwin. There is also a good woodcut of the interior of Dr. Darwin's study at Down.

Messrs. Dean & Son publish two handbooks which will be most useful to all lovers of feathered pets, viz. *Foreign Aviary Birds*, by Dr. Karl Rues, and *Macaws, Cockatoos, Parrakeets, and Parrots*, by the late Sir Thomas Dick Lauder, Bart., F.R.S.E., and Captain Brown, F.L.S. The former, translated into English by Mr. Cassirer, devotes itself principally to the treatment and diseases of the birds; the latter is a useful compendium of their natural history.

Graphic Pictures of Native Life in Distant Lands (London: George Philip & Son), will make a good gift book for a child. It contains twelve coloured illustrations, full of incident, and the letterpress is not only instructive but entertaining.

The Medico-Legal Journal (New York: "Medico-Legal Journal" Association, 1888) contains the leading papers read at the meetings of the New York Society of that name. Vol. VI., No. 1, is devoted, for the most part, to the consideration of the interesting question, How far the inebriate possesses sufficient self-control to render him responsible for his actions? That the inebriate, in the strict definition of the term, is one upon whom the sins of his parents are visited, is shown most clearly by Dr. Parrish, who gives instances where such a man, leading in general a most respectable and also abstemious life, is at times irresistibly impelled to excess. Dr. Crothers criticises the ordinary procedure in courts of justice in such cases,

and claims that the evidence of scientific witnesses should include matters not hitherto considered relevant to the inquiry.

Alpine Winter in its Medical Aspect. By A. TUCKER WISE, M.D., L.R.C.P., M.R.C.S. (London: J. & A. Churchill. 1888.)—Every year the medical world is more and more appreciating the value of a winter residence for the treatment of chest diseases. It is therefore with much pleasure that we hail the appearance of a new edition of Dr. Tucker Wise's book. He does not confine himself merely to a geographical description of the regions most frequented, but gives an instructive explanation of the causes which operate towards the cure of phthisis, or at any rate towards its temporary alleviation. We are told when to come and when to go; where the water is purest, the air driest, and the sunlight most profuse. The drawbacks are also briefly sketched, and a doctor's opinion before starting is in every case recommended.

Juvenile Literature As It Is, by EDWARD SALMON (London: H. J. Deane), will be found most useful to those who seek aid in choosing Christmas presents for their young friends, and gives a very good idea of the books written expressly for girls and boys. The girls and boys are first made to speak for themselves in statistics collected by Mr. Charles Welsh, though Mr. Salmon evidently doubts, and we certainly share his doubt, how far such statistics are trustworthy indications of the opinion of young people. For the rest, Mr. Salmon gives a careful, and yet not too lengthy, criticism of each writer whom he considers worthy of notice.

Messrs. Cassell & Co. state that the changes in the educational system of the country, as well as the advances made in literature and science, have induced them to publish in a revised form the *New Popular Educator*. The first part lies before us; it appears to have been carefully revised, and we trust it will be as useful in spreading and popularising knowledge as its predecessor was.

Moffatt's edition of Shakespeare's Macbeth (London: Moffatt & Paige, 1888), is destined to assist candidates for the Oxford Local and Government certificate examinations. It is a work of decided merit. A feature of the book is that each subject treated of is kept distinct from the rest; the literary notes precede, and are subdivided into classes under their appropriate headings, while the notes to the text are grammatical and philological only. On the whole it will be as useful to the general reader as to the examinee, and will be a handy book of reference.

The translation of *Racine's Iphigenie* (the same publishers) is a less ambitious work. It is not supplied with notes, and lays too much stress on a faithful translation of the original, to the neglect of force and freedom of expression.

THE FACE OF THE SKY FOR DECEMBER.

BY HERBERT SADLER, F.R.A.S.

THE solar surface, though not absolutely quiescent, exhibits but few traces of activity. December 21 is the date of the winter solstice. Map xii. of "The Stars in their Seasons" shows the brighter stars visible in the December night sky. The most conveniently observable minima of Algol occur on December 9 at 11h. 54m. P.M., on the 12th at 8h. 43m. P.M., and on the 15th at 5h. 32m. P.M. The first trace of diminution of light in this variable commences about 4½ hours, and the most rapid decrease about 1h. 40m., before the actual time of minimum, when the star's light remains constant at 3·7 magnitude for about a quarter of an hour; in about 4½ hours after minimum the star regains its normal brilliancy of 2·2 magnitude. The long period variable Omicron (Mira) Ceti, which was a bright third magnitude about the beginning of October, has now sunk to nearly the 6th magnitude, and is barely visible to the naked eye. Minima of Lambda Tauri take place on the 4th at 6h. 30m. P.M., and on the 8th at 5h. 21m. P.M. In this star the change of light from the normal brilliancy (3·4 magnitude) to minimum (4·2 magnitude) and back again takes a little more than 10 hours. A well-marked shower of shooting stars, known as the Geminids, occurs on the nights of December 9-12. The radiant point is in 7h. 8m. right ascension and 32° north declination (about 5° west of Castor), and rises on December 10 about 4h. 10m. P.M. Mercury is practically invisible, as, though he rises 1h. 26m. before the sun on the 1st of the month, his apparent diameter has decreased considerably, and he is very near the horizon. He comes into superior conjunction with the sun on the 28th. Venus is an evening star, and during the first portion of the month has too great southern declination to be easily observed in these latitudes; but her position improves daily, and towards the end of the month she is fairly well situated for observation, setting, on December 31, at 7h. 38m. P.M., or 3h. 40m. after the sun. Her gibbous disc then subtends an apparent diameter of 16″. Mars is also *visible* in the evening, but simply as a large red star, his apparent diameter being too small to permit of the observation of any of the markings on his disc. On the 31st he will be only about 1° to the NE. of Venus. Jupiter is in conjunction with the Sun on the 8th, and is, of course, invisible throughout the month. Saturn is very well placed for observation, rising as he does at 9h. 20m. P.M. on the 1st, and at 7h. 16m. P.M. on the 31st, with a fair north declination. He is situated to the WNW. of Regulus, in a region barren of conspicuous stars. On the evening of the 27th he will be about 1° due north of the pretty little pair 7 Leonis, a star just visible to the naked eye. Uranus, rising at more than an hour after midnight on the last day of the month, is not likely to attract the attention of the amateur observer. Neptune may still be picked up as a dull 8th magnitude star by any one who possesses sufficient optical power, and who knows the planet's precise position. He is still between the Hyades and Pleiades, and is slowly retrograding. Comet *e* (1888), discovered by Mr. Barnard at the Lick Observatory on September 2, attained its greatest theoretical brightness about the third week in November, but in the absence of bright moonlight it will probably be distinctly visible, if not to the naked eye, at all events in an opera-glass, throughout the whole of December. At 8 P.M. on the 2nd of the month the comet will be about ½° south following the 6th magnitude star 67 Ceti; about the same time on the 9th the comet will be nearly a degree preceding, a little to the north, another 6th magnitude star in the same constellation, which bears the number of 2848 in the great catalogue of Lalande; while a few minutes before midnight on the 10th the nucleus of the comet will cross the bright round nebula H I. 100 Ceti, which has a very faint nebula accompanying it at about 16 seconds of time preceding and 90″ south, which will of course also suffer occultation. There are several instances of stars having been occulted by comets, but, so far as we are aware, no comet has ever been seen in transit over a nebula. Of course the nebula, which is about 1′ in diameter, will be enveloped in the cometary appendages some time before the actual transit of the brighter part. On the evening of the 31st the comet will be some 2° north following the bright star Iota Ceti. Barnard's second comet (*f* 1888) is diminishing in brightness, and is not likely to be picked up by the amateur observer. There will be two occultations of stars by, and two near approaches of stars to, the moon in the month of December. On the 17th, at 3h. 31m. A.M., the 6th magnitude star B.A.C. 1468 will approach the lunar limb at an angle of 229° from the vertex, and at 6h. 1m. A.M. on the same morning the 5½ magnitude star *i* Tauri will approach at an angle of 223°. These near approaches will be best seen in northern latitudes. On the evening of the same day the 6½ magnitude star B.A.C. 1651 will be occulted at 5h. 42m. P.M., the disappearance taking place at an angle of 106° from the vertex, and the reappearance at 6h. 26m. P.M., at an angle of 243° from the vertex; while at 1h. 17m. A.M. on the following morning the 6½ magnitude star B.A.C. 1733 will disappear at an angle of 161° from the vertex, reappearing at 2h. 19m., at an angle of 273°.

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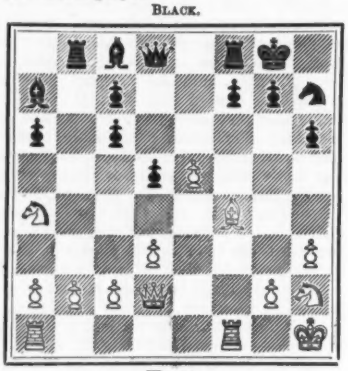
Our Chess Column.

BY "MEPHISTO."

WITH the following illustrations we intend to convey to our playing readers a correct idea of the methods of attack pursued by strong players in certain positions by analytically examining a few moves played.

BLACK.



WHITE.

Black to move.

In examining this position on behalf of Black, we must put ourselves in the position of the player himself, who firstly will look round to see whether any immediate attack by White is to be feared on any point. Looking at the King side we see a possibility of a surprise by White playing B × KRP followed up by Q × RP, but then at the present moment this sacrifice would not pay, for after 1. B × P, P × B. 2. Q × P, B to Q2 there is not much danger for Black as he will be able to defend by Q to Kt4, but then we must always be on our guard as White may obtain a more favourable opportunity for B × RP, and the necessity for keeping our pieces in a favourable position, available for the purpose of defence in case of the sacrifice, will weaken our action on the Queen's side and correspondingly strengthen White. If, for example, he should play P to Q4 with the idea of attacking the QBP by playing R to KB3 followed by R to QB3, he will be very much assisted by Black's position on the King's side, for not only is Black prevented from freely moving his pieces, because, for instance, he must keep the Queen in a position available to play to Kt4 if necessary, but White by R to B3, in the pursuit of the QBP, also threatens R to Kt3, which might make the sacrifice far more effective. As a matter of principle it is highly desirable not to remain under a threat of this kind. K to Rsq would be a useful precautionary move, but then before doing this we must see if there is nothing more pressing demanding immediate attention. We have mentioned P to Q4. Now, if White plays P to Q4, it is apparent that the Black KB is shut out entirely from the game. Nor do we see any chance of extricating him, because White might follow up P to Q4 by likewise playing P to QKt4 and P to B3 and P to QR3, completely blocking the Queen's side, a very undesirable contingency. To prevent this calls for more urgency than K to Rsq, and we can do this by playing

1. P to QB4.

This move makes P to Q4 impossible; it may also enable us to gain time, by playing B to Q2, and if, then, the Kt retires from R4—which, sooner or later, it must do, for the Kt is always badly placed on R4—we might be able to play QR to Kt3 in defence of the threatened K's side, or even possibly get up a counter attack thereby. The best move is the one which defends attackingly:—White played

2. P to QKt3

This should give us the desired opportunity of developing our game on the lines indicated in the previous note, and our opportunity has arisen through the mere fact of White having been compelled to play the purely defensive move of P to QKt3, which does not actively affect the position, and which, in a measure, is a loss of time. We therefore play

2B to Q2

Again developing attackingly, for we threaten, by B × Kt, to weaken White's Pawns very much. If White played 3Q to R5, we should temporarily defend our isolated RP by Q to Bsq, and afterwards play B to Kt3, compelling White to play Kt × B, reuniting our Pawns

3. Kt to Kt2

This move gives us the desired opportunity, and we play accordingly—

3. R to Kt3

But in doing so we are influenced by the fact that two hostile Bishops—so unfavourable to the movement of Rooks in the open—are not on the board, and that the B remaining on the board is of Black colour, which will enable our Rook to play KKt3, when he will be very well posted. But we are also influenced by the fact that White threatens to bring his QKt over to the King side, *viâ* Qsq and K3, and thereby direct a strong attack against our King side; we prevent this by our counter attack. Thus it may again be seen that active play or even attack is the best defence, nay, is absolutely essential to good play. White played—

4. Kt to B3

Now it would not do to play the Rook to Kt3 at once, in front of the Pawns, for without the advance of the Pawns, there is not much chance of a solid attack being obtained, for although there is no hostile White B on the board, yet it will not do to play Rooks rashly in the open, exposing them to the attack of the minor pieces; White might easily be able to play his Kt to R4 so as to dislodge the Rook. The Rook as a rule is powerful in support of advancing Pawns, we therefore play

4. P to Kt4

particularly as we gain time, for by doing so, we attack a piece which is compelled to move.

5. B to Kt3 5. R to Kt3

and Black has a very fair attacking position. By this illustration it will be seen that a few well-directed and active moves may transform an inferior into a superior position.

CONSULTATION GAME PLAYED AT SIMPSON'S DIVAN.

VIENNA OPENING.

WHITE. Messrs. Evans and Pollock.	BLACK. Mr. F. Lee and another.	WHITE. Messrs. Evans and Pollock.	BLACK. Mr. F. Lee and another.
1. P to K4	P to K4	16. P × P *en p.*	R × P
2. QKt to B3	P to Q3 (*a*)	17. P to KR4	P to KR4
3. P to Q4	B to K2	18. P to Kt5	Kt to Ktsq
4. Kt to B3	Kt to Q2	19. B to K3	R to Ksq
5. B to QB4	Kt to Kt3	20. P to B4	B to Qsq
6. B to Kt3	P × P	21. Q × P	P to QB4?
7. Kt × P	Kt to B3	22. P to B5 (*f*)	R to Kt2
8. B to KB4 (*b*)	B to Kt5	23. P to B6	R to Kt3
9. P to B3	B to R4	24. Q × R (*g*)	P × Q
10. Kt to B5 (*c*)	KR to Ktsq (*d*)	25. P to B7	P to B5
11. Q to K2!	B to Kt3	26. P × R (qu. ch)	Q × Q
12. Castles (QR)	B × Kt	27. B × Kt	Q to B3
13. P × B	Q to Q2	28. R to Bsq (ch)	K to K2 (*h*)
14. KR to Ksq	K to Bsq	29. QR to K (ch)	Resigns.
15. P to Kt4	P to Kt4 (*e*)		

NOTES.

(*a*) An indifferent defence, though safe. The opening assumes a curious likeness to certain forms of Philidor's defence.

(*b*) In this kind of position it is generally best to prepare early to castle on the Queen's side. White has already an undeniable advantage.

(*c*) Well played, as Kt × B may follow, if necessary, without any loss in time.

(*d*) Castling would obviously expose the second players to a powerful attack.

(*e*) The extreme weakness of Black's position is shown by this move. In nine cases out of ten an exchange of pawns *from* the centre is accompanied by a deterioration of position, but here White's game is in no wise damaged by the operation.

(*f*) A powerful rejoinder to Black's last move, which in some measure seemed to promise relief to their constraint.

(*g*) Finely conceived and perfectly sound.

(*h*) If K to Kt2, 29. B to Q4(ch), and wins.

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